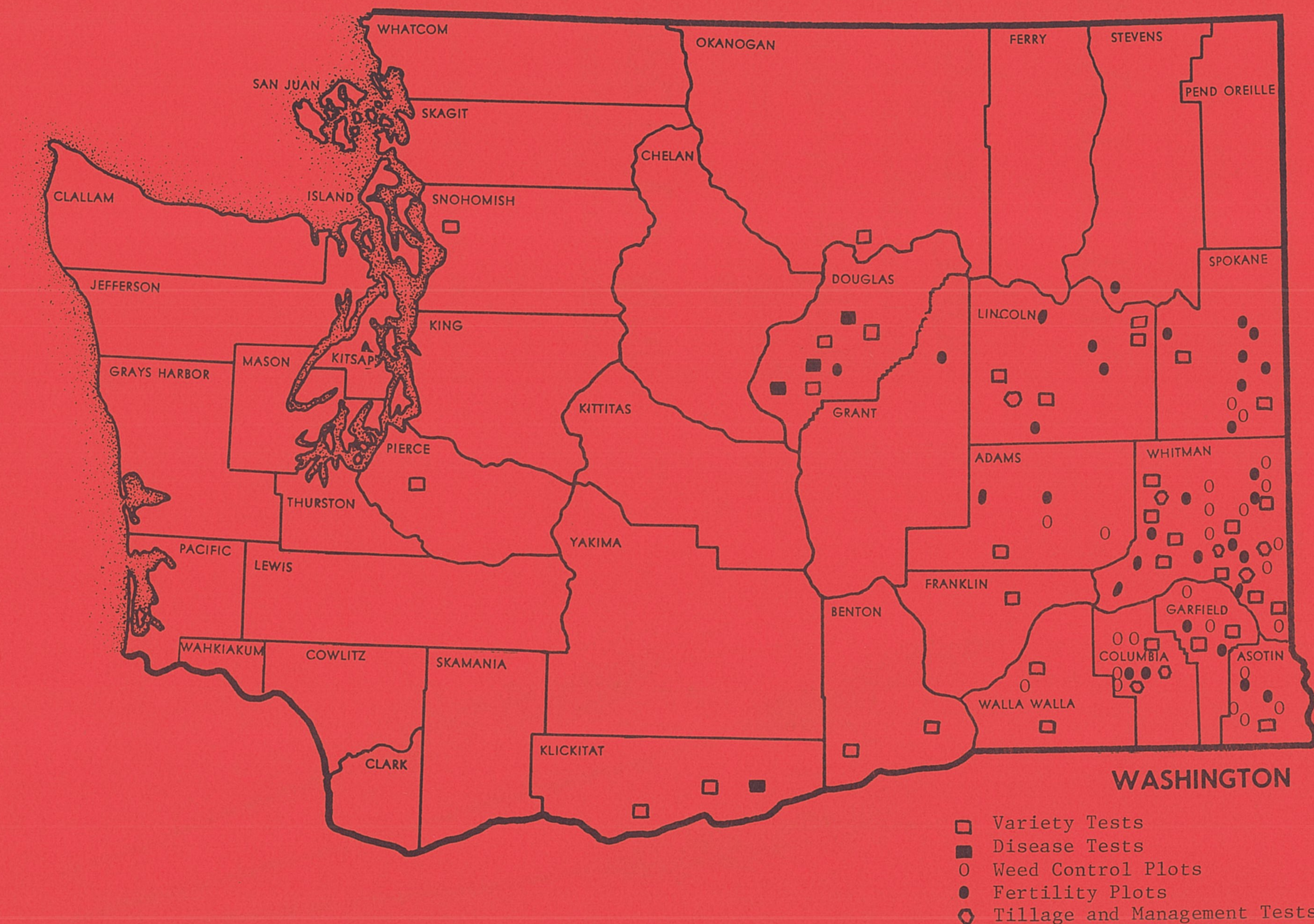
WSU FIELD DAYS

~~June 19, 1980~~
Dry Land Research Unit, Lind

~~July 1, 1980~~
Palouse Conservation Station
Field Day, Pullman

July 10, 1980
Spillman Farm, Pullman

June 19, July 1 Field Days have been cancelled.


WHATCOM
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JEFFERSON
DOUGLAS
LINCOLN
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GRAYS HARBOR
KITTITAS
GRANT
PIERCE
ADAMS
WHITMAN
THURSTON
YAKIMA
PACIFIC
LEWIS
FRANKLIN
BENTON
GARFIELD
WAHKIAKUM
COWLITZ
SKAMANIA
COLUMBIA
ASOTIN
WALLA WALLA
KLICKITAT
CLARK
WASHINGTON
Variety Tests
Disease Tests
Weed Control Plots
Fertility Plots
Tillage and Management Tests

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HISTORY OF DRY LAND RESEARCH UNIT

On April 1, 1915, Experiment Station Director I. D. Cardiff announced the establishment of the Adams Branch Experiment Station. It was "created for dissemination of information and conduction of demonstrations and experiments in the semi-arid portion of the state."

Adams County has played an important part in the history of the station. The county donated $6000 to start the station and the land has been donated by the county. In the early 30's during the depression, Adams County kept the station alive with a small appropriation until the College could fund the operation again. In 1965 Adams County deeded 318 acres to Washington State University; two acres were previously deeded to make a total of 320 acres in the Dry Land Research Unit.

The first superintendent was the late Dr. M. A. McCall. Dr. McCall was a gifted researcher given somewhat to philosophy in his early reports. In a 1920 report he outlined the fundamental reasons for an outlying experiment station. He stated, "A branch station, from the standpoint of efficiency of administration and use of equipment, is justified only by existence of certain problems, which, because of special conditions such as climate, soil, etc., cannot be studied at a central station." For over fifty years this station has followed this policy of studying the problems associated with the 8 to 12 inch rainfall area.

In 1947 the station was named the Dry Land Experiment Station. This name was changed again in 1965 to the Dry Land Research Unit. In 1972, the administration of the station was moved into the Department of Agronomy and Soils. Although the administration has changed, the station is still devoted to dry land research. This experiment station has the lowest rainfall of any research station devoted to dry land research in the United States.

The present facilities include a machine storage built shortly after the station was established. The old barn was dismantled in April 1973 and the residence in 1979. A small elevator was constructed in 1937 for grain storage. A modern office and attached greenhouse were built in 1949 after the old office quarters were burned. In 1960 a 40' x 80' metal shop was constructed with WSU general building funds. In 1964 an addition to the greenhouse was built with a Washington Wheat Commissions grant of $12,000 to facilitate breeding for stripe rust resistance. In 1966 a new deep well was drilled testing over 430 gallons per minute. A pump and irrigation system were installed in 1967. With the addition of a 12' x 60' trailer house residence improvements in 1966 and 1967 amounted to over $35,000 with more than $11,000 of this from Wheat Commission funds and the remainder from state funds. The major portion of the research has centered around wheat. Variety adaptation, wheat production management including weed and disease control, and wheat breeding are the major programs of research in recent years. Twenty acres of land can be irrigated for research trials. Although many varieties of wheat have been recommended from variety trials by the station, Wanser and McCall were the first varieties developed on the station by plant breeding.

Since 1916 an annual field day has been held to show farmers and interested businessmen the research on the station. This year marks the 63rd field day. Visitors are welcome at any time. Their suggestions are appreciated.

IRRIGATION AT THE DRY LAND RESEARCH UNIT

Every year the question is raised as to why irrigation is used on an experiment station which is located in, and devoted to, research for the wheat-summerfallow area of Eastern Washington.

In the research conducted on the station, irrigation serves one or more of five purposes: 1. Insures the establishment of a good stand of wheat where the main purpose of the research would fail with an inadequate stand. Instances of this use are the dryland foot rot trial where plants must be stressed to fully express the disease, fertilizer trials, and disease nurseries. 2. Foliar diseases, leaf rust and stripe rust, are much more severe under irrigation, due to the heavier foilage and the fungi's requirement of free water on the plant leaves for infection. The foot rots, strawbreakers and take-all (a problem only under irrigation) are more severe and it is easier to obtain infection with the aid of water management. 3. Irrigation aids in stand establishment and in increasing the volume of seed harvested where a limited quantity of seed is available for testing and increase as in the case of seed from individual seeds or plants. 4. Certain agronomic traits, such as lodging resistance, shatter resistance, tillering capacity, potential yield capacity, and plant height are more readily determined from one or two seasons under irrigation than from many years of testing on dry land. 5. With an increase in irrigation and supplemented irrigation in the area, there is a need for research in these areas. One experiment on the station is concerned with annual cropping winter wheat under supplemental irrigation. The irrigated winter and spring wheat trials are designed to determine the agronomic trials which cannot be easily determined under dry land conditions as well as test the selections for yield and quality under irrigated culture.

The primary purpose of irrigation on the Dry Land Research Unit is not to aid in the development of wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the dryland wheat summerfallow region.

HISTORY OF SPILLMAN FARM

In the fall of 1955, 222 acres of land were acquired from Mr. and Mrs. Bill Mennet at the arbitrated price of $420 per acre. The money for the original purchase came as the result of a fund drive which raised $85,000 from industry and wheat growers. In addition $35,000 came from the Washington State University building fund; $11,000 from the State Department of Agriculture and another $10,000 from the 1955-57 operating budget. The dedication of the new facility took place at the Cereal Field Day July 10, 1957. In 1961 the Agronomy Farm was named Spillman Farm after the distinguished geneticist and plant breeder at Washington State University in the late 1880's.

Through the dedicated efforts of many local people and the initiative of Dr. Orville Vogel, arrangements were made to acquire an additional 160 acres north of the headquarters building in the fall of 1961. This purchase was financed jointly by the Wheat Commission and Washington State University. The newly acquired 160 acres was fenced and the wetland drained: it became an integral part of the Agronomy Farm now consisting of 382 acres.

The headquarters building, which is 140 feet long and 40 feet wide, was completed in 1956. In 1957 a well that produced 340 gallons per minute was developed. In 1968 the Washington Wheat Commission provided funds for a sheath storage facility, that was necessitated by the increased research program on the farm. At the same time the Washington Dry Pea and Lentil Commission provided $25,000 to build a similar facility for the pea and lentil materials. The facilities of the Spillman Agronomy Farm now range in value well over a half-million dollars.

The Spillman Agronomy Farm was developed with proper land use in mind. A conservation farm plan which includes roads, terraces, steep slope plantings, roadside seedings, and a conservation crop rotation including alfalfa and grass has been in use since the Farm was purchased.

George Varner, was appointed farm manager in 1974.

CLIMATIC DATA

The climatic conditions in the low rainfall area of eastern Washington commonly called the Big Bend Area, are unique when compared to Great Plains wheat producing areas. As shown in Table 1, about 90% of the rainfall occurs from September 15 to June 30. This rainfall pattern coincides with the normal winter wheat growing season. In most wheat production areas outside the Pacific Northwest, a spring-summer rainfall pattern occurs. The efficiency of the moisure utilization is greater under our rainfall pattern with lower evaporation-transpiration rates during the months of maximum precipitation in both summerfallow and crop years.

Table 1. Average temperature and precipitation at Dry Land Research Unit, Lind.

Month	Temperature °F.		Precipitation		Precipitation
	Max.	Min.	1979	1980	59 yrs. av. (in)
January	34	22	.79	1.44	1.03
February	42	24	1.07	1.47	.87
March	53	32	.74	.68	.73
April	63	35	1.64	.64	.66
May	72	42	.61		.75
June	83	45	.12		.86
July	90	52	.24		.24
August	90	50	.43		.34
September	79	45	.54		.54
October	65	38	1.49		.86
November	47	29	1.31		1.20
December	37	26	.89		1.27
			9.87		9.35

Climatic measurements are made daily with standard U.S. Weather Bureau instruments. Data recorded are maximum and minimum temperature, daily precipitation, relative humidity, daily wind movement, and daily evaporation. In addition, automatic instruments make a continuous record of soil and air temperatures and precipitation.

Table 1. Temperature and Precipitation at Palouse Conservation Field Station, Pullman, 1979 and 1980

	Average Temperature °F		Precipitation				
			30-Yr.		Total	Deviation from Avg.	
Month	Max.	Min.	Avg.	Monthly	Accum.	Monthly	Accum.
1979							
January	21.7	7.1	2.67	1.24	1.24	−1.43	−1.43
February	36.6	24.5	2.10	3.81	5.05	+1.71	+0.28
March	49.2	32.3	2.12	1.75	6.80	−0.37	−0.09
April	53.0	36.2	1.49	2.67	9.47	+1.18	+1.09
May	64.5	43.2	1.46	1.70	11.17	+0.24	+1.33
June	73.4	46.4	1.54	0.94	12.11	−0.60	+0.73
July	81.4	49.6	0.39	0.45	12.56	+0.06	+0.79
August	82.3	51.0	0.52	1.45	14.01	+0.93	+1.72
September	76.5	46.9	1.08	0.31	14.32	−0.77	+0.95
October	61.7	39.4	1.91	2.11	16.43	+0.20	+1.15
November	39.5	27.0	2.47	1.74	18.17	−0.73	+0.42
December	41.2	29.0	2.74	2.15	20.32	−0.59	−0.17
TOTAL	59.7	36.0	20.49	20.32	20.32	−0.17	−0.17
1980							
January	30.0	16.3	2.67	3.08	3.08	+0.41	+0.42
February	40.0	29.4	2.10	1.50	4.58	−0.60	−0.19
March	44.4	30.4	2.12	2.42	7.00	+0.30	+0.11
April	60.2	39.7	1.49	1.21	8.21	−0.28	−0.17
May 13*	65.0	44.1	1.46	0.92	9.13	−0.54	−0.71
TOTAL	47.9	42.0	9.84	9.13	9.13	−0.71	−0.71
1979 CROP YEAR Sept. 1979-May 13, 1980			18.04		15.44		−2.60

*Partial month.

RECOMMENDED VARIETIES—WHEAT, OATS, BARLEY

AREA	WINTER WHEAT	SPRING WHEAT	OATS	SPRING BARLEY	WINTER BARLEY
EASTERN WASHINGTON					
14 Inches or More Rainfall	Nugaines Luke Paha Hyslop McDermid Daws Barbee Stephens Faro Tyee	Fielder Urquie	Cayuse Park Appaloosa	Steptoe Advance Larker—malting barley Belford—for hay only Vanguard—malting barley Blazer—malting barley	Kamiak Boyer
EASTERN WASHINGTON					
Less Than 14 Inches Rainfall	Wanser McCall Moro Paha Nugaines Sprague Barbee Faro	Sawtell Wampum Wared Twin		Steptoe	
CENTRAL WASHINGTON					
Under Irrigation	Nugaines Hyslop Daws Stephens Walladay Wandell (Durum)	Fielder Urquie Sawtell Wared Wampum	Cayuse Park Appaloosa	Steptoe Belford—for hay only	Boyer
Snow Mold Areas	Sprague				

WHEAT, OATS, AND BARLEY

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Washington State University

Winter Wheat

Nugaines

Nugaines is a soft white semidwarf winter wheat with excellent test weight, milling, and baking properties. The variety has a bearded, common-type head with white chaff.

Nugaines is not as winterhardy as Daws or the hard red winter wheats McCall or Wanser but is hardier than Luke and Paha.

Nugaines has good mature plant resistance to stripe rust but is susceptible to stripe rust in the seedling stage. It is also susceptible to leaf rust, dwarf bunt, snow mold, and *Cercosporella* foot rot.

Nugaines is resistant to most races of common bunt and has moderate resistance to flag smut and *Cephalosporium* stripe (fungus stripe). Nugaines was developed by SEA-USDA and Washington State University.

Luke

Luke is a late maturing soft white semidwarf winter wheat. Luke is resistant to most races of common and dwarf bunt and is well-adapted to areas where dwarf bunt is a problem. This variety is slightly better than most commercial varieties in resistance to *Cercosporella* foot rot, snow mold, and stripe rust. Luke is moderately susceptible to leaf rust, flag smut, and *Cephalosporium* stripe (fungus stripe). It emerges well for a semidwarf.

Luke is less winterhardy than Nugaines. The milling quality is unusually good for soft white wheat and the baking quality is similar to Nugaines. Its resistance to lodging and shattering are slightly less than that of Nugaines. Luke was developed by SEA-USDA and Washington State University.

Daws

Daws is a soft white common semidwarf winter wheat. The variety has about a 5-percent yield advantage over Nugaines. It is more winterhardy than Nugaines but is not as hardy as Wanser or McCall.

Daws has good milling property and the flour quality is satisfactory. The variety emerges slower than Nugaines. Daws has good stripe rust resistance but is susceptible to *Cercosporella* foot rot, snow mold, dwarf smut, and *Cephalosporium* stripe (fungus stripe). It is moderately susceptible to leaf rust. Daws was developed by SEA-USDA and Washington State University.

Stephens

Stephens is a soft white common wheat released at Oregon that is resistant to stripe rust and common smut. It is moderately resistant to *Cercosporella* foot rot. Stephens is susceptible to leaf rust, dwarf smut, flag smut, snow mold, and *Cephalosporium* stripe (fungus stripe). It is similar to

Nugaines in emergence. The grain yields of Stephens are slightly higher than Nugaines, McDermid, and Hyslop. Stephens has the same winterhardiness as Hyslop. The milling and flour qualities of Stephens are similar to that of Nugaines. Stephens was developed by Oregon State University.

McDermid

McDermid is a semidwarf soft white common winter wheat. It has weaker straw than Hyslop. McDermid has more winterhardiness than Hyslop but is not as hardy as Nugaines.

McDermid is similar to Nugaines in common smut reaction but is susceptible to most races of dwarf smut and *Cephalosporium* stripe (fungus stripe). The variety is moderately resistant to stripe rust and leaf rust. McDermid has shown a slightly lower yield than Nugaines in yield trials in Washington. The variety has performed the best in the northcentral areas of Oregon and southern areas of Washington. The milling and flour characteristics of McDermid are similar to Nugaines. McDermid was developed by Oregon State University.

Hyslop

Hyslop is a soft white semidwarf winter wheat that yields well in high rainfall areas or with irrigation. Hyslop has a slightly better yield record than Nugaines where winter injury is not a factor. Insufficient winterhardiness limits the use of Hyslop in eastern Washington. Coldhardiness tests have shown Hyslop to lack the winterhardiness of such varieties as Paha, Luke, McDermid, Nugaines, and Daws.

Hyslop is resistant to common bunt, stripe rust, and susceptible to dwarf smut, flag smut, leaf rust, and *Cephalosporium* stripe (fungus stripe).

Milling and baking qualities of Hyslop are similar to Nugaines. Hyslop was developed by Oregon State University.

Sprague

Sprague is a soft white common wheat developed for the snow mold areas. The chaff varies white to gray-brown; the heads are small and awned. It has high tillering capacity from early seedings but the straw is weak. The test weight of Sprague is below Nugaines but is has been above 60 pounds per bushel.

Sprague has good resistance to snow mold and common bunt but is susceptible to dwarf bunt, stripe and leaf rusts, and *Cercosporella* foot rot.

It has excellent emergence and good winterhardiness. Sprague was developed by SEA-USDA and Washington State University.

Barbee

Barbee is a semidwarf soft white club winter wheat with a bearded head. The variety has a slightly higher yield record than other club wheats. Barbee is not as good as other club wheats in emergence.

The variety has good stripe rust resistance and is resistant to flag smut and most races of dwarf smut, and moderate resistance to *Cephalosporium* stripe (fungus stripe). It produces an excellent flour but it mills more like a soft white common wheat variety than a club wheat variety.

Barbee is expected to replace Paha because of the higher yield record and better stripe rust resistance. Barbee was developed by SEA-USDA and Washington State University.

Tyee

Tyee is a soft white club winter wheat with compact heads and awnless white chaff. It is a semidwarf wheat that is medium in maturity. The variety has high resistance to stripe rust that is different from the resistance in Moro, Barbee, and Faro.

The emergence is about the same as Paha. Emergence would be slower than Moro. The variety is moderately susceptible to flag smut. It has about the same common bunt or common smut resistance as Nugaines. It is susceptible to dwarf bunt. Tyee has the same susceptibility to leaf rust as Barbee, Faro, and Moro. The variety is highly susceptible to mildew. Tyee has about the same tolerance to strawbreaker foot rot as Barbee. It is more tolerant than Paha or Nugaines. Data is not available on *Cephalosporium* stripe (fungus stripe).

Tyee has high yielding ability, exceeding Paha, Moro, and Barbee and often better than Faro. It has test weight comparable to Moro and Barbee. It is 1 to 2 inches taller than Faro, 1 to 5 inches taller than Nugaines, and 5 inches shorter than Moro. Tyee has more lodging resistance than Paha and considerably more resistance than Moro.

The variety has about the same winterhardiness as Nugaines and, under some conditions, may prove to be better than Nugaines.

The quality of Tyee is similar to Moro but somewhat lower in quality than Paha. It may be superior to Faro for low ash content and increased cookie diameter. The variety was developed by wheat breeding and production of USDA-SEA-AR and released jointly by the Washington, Oregon, and Idaho Agriculture Experiment Stations.

Paha

Paha is a short, standard height, white club wheat. It is susceptible to some races of stripe and leaf rusts, powdery mildew, and flag smut. It has moderate resistance to *Cercosporella* foot rot and *Cephalosporium* stripe (fungus stripe). The variety is resistant to lodging and shattering. Good germination and emergence characteristics of the selection are similar to other club wheats but not as good as Moro.

The variety is adapted to areas that produce the quality of club wheats desired by domestic and foreign markets. Paha was developed by SEA-USDA and Washington State University.

Faro

Faro is a semidwarf soft white club. It has a good yield record in the southern part of the wheat-producing area but does not have as good emergence as Moro. Faro is resistant to stripe rust and common bunt but is susceptible to flag smut, snow mold, and dwarf bunt. It is moderately resistant to dwarf bunt, foot rot, and *Cephalosporium* stripe (fungus stripe). Faro has equaled or exceeded the grain yields of Paha and it is similar to Paha in emergence and winterhardiness. Faro was developed by Oregon State University.

Moro

Moro is a soft white club winter wheat with brown chaff. Its chief advantages are resistance to stripe rust and excellent emergence. It is susceptible to leaf rust. When stripe rust is severe, Moro produces much better yields than stripe rust susceptible varieties. Moro is resistant to most races of dwarf bunt and common bunt. Moro is moderately resistant to *Cephalosporium* stripe (fungus stripe).

Moro is a good pastry flour; however, it has a higher flour viscosity than other club varieties. Moro is a medium-tall club variety with white kernels. Moro does not have the high yield potential of other club varieties in the higher rainfall areas. In the lower rainfall areas of Washington, where it is difficult to obtain stands with other varieties, Moro will germinate and emerge much better than other varieties from deep seedings in dry, dusty seedbeds. Moro was developed by Oregon State University.

Wanser and McCall

Wanser and McCall are hard red winter wheats developed for low rainfall areas of Washington. Both varieties yield well in areas that have less than 13 inches of annual rainfall. The two varieties can be distinguished by chaff color. Wanser has a brown-chaffed head and McCall has a white-chaffed head. Both have bearded, lax spikes.

Both varieties are resistant to common smut and most races of dwarf bunt. Wanser shows superiority over McCall in stripe rust tolerance and winterhardiness is important for maximum production.

McCall is well-adapted to the northern section of the Big Bend area, including Douglas, Grant, and Lincoln Counties. McCall is superior to Wanser in both snow mold tolerance and emergence from deep seedings—two qualities important to production in that area. McCall recovers rapidly in the spring which is another advantage for the northern area.

McCall has good winterhardiness, but less than Wanser. Both Wanser and McCall are more winterhardy than Nugaines, Daws, or the club wheats. Wanser and McCall are shatter resistant.

Wanser mills better than McCall. McCall has slightly better bread-baking qualities than Wanser. Neither is suitable for production of soft white wheat products. Wanser and McCall were developed by SEA-USDA and Washington State University.

Spring Wheat

Urquie

Urquie is a semidwarf, awned, white-chaffed, soft white spring wheat developed by Washington State University and SEA-USDA.

Urquie is lodging resistant. The test weight of Urquie is equal to that of Fielder and superior to that of Twin. Urquie is expected to yield competitively with Fielder and Twin, especially in the low rainfall areas of Washington. Urquie is resistant to many prevalent races of stripe rust but is susceptible to leaf rust and has moderate susceptibility to mildew.

Fielder

Fielder is a soft white spring wheat developed by SEA-USDA and the Idaho Branch Experiment Station at Aberdeen, Idaho. Fielder is a semidwarf, stiff-strawed, white-chaffed, awned variety with moderate resistance to common races of leaf rust but is susceptible to a new race present in the area. Fielder has moderate resistance to earlier races but is highly susceptible to a recently prevalent race of stripe rust, and is moderately susceptible to mildew. Fielder has established a higher yield record than Twin or Marfed in the higher rainfall areas of eastern Washington. Fielder yields about the same as Marfed in lower rainfall areas. Test weight of Fielder averages about 2 pounds per bushel more than Twin and about the same as Urquie.

Facultative Wheats

Walladay

Walladay is a soft white, semidwarf, facultative wheat developed by Washington State University and SEA-USDA. The variety has an awned common white-chaffed head. Kernels are white and mid-size. The variety is adapted to fall seedings in southeast Washington wheat-producing areas. The winterhardiness is not adequate to recommend growing Walladay in the other wheat-producing areas as a winter wheat.

From fall seedings in southeast Washington, yields of Walladay are competitive with Nugaines. From spring seedings, the variety is competitive with Fielder and Urquie.

Walladay is very susceptible to *Cercosporella* foot rot. The variety is moderately resistant to stripe rust, resistant to previous leaf rust, but susceptible to a new leaf race recently in the area. Walladay is slightly earlier than Luke but is a later maturing variety than Urquie or Fielder when spring seeded.

Spring Barley

Steptoe

Steptoe is a 6-row, rough-awned, spring nonmalting barley with a high yield record. The test weight is high. Steptoe heads later than most 6-row varieties. The variety has stiff straw with good lodging resistance. The straw is medium tall. The heads are erect with rough awns. The variety is not acceptable for malting. Steptoe was developed by Washington State University.

Advance

Advance is a 6-row spring variety with good potential as a malting variety. The variety has low or no cold tolerance and, therefore, it is very likely to winterkill which will reduce the problem of volunteer barley in subsequent crop rotations. This is especially important when wheat is grown after barley.

This extreme earliness will permit Advance to mature under more favorable conditions. Advance is a short, stiff-strawed variety. Additional tests indicate that Advance has a higher feed value for livestock than Steptoe but it yields only 93 percent as much grain as Steptoe. Advance has some susceptibility to mildew but in trials where this disease has been prevalent yield losses were not detectable and malting quality was not impaired.

Advance has a tendency to develop thin kernels under adverse conditions. The variety does produce more plump and less thin kernels than Blazer. Advance was developed by Washington State University.

Blazer

Blazer is a 6-row malting-type barley with rough awns. Blazer is expected to replace Traill and Larker, midwest malting barleys presently grown in Washington, Oregon, and Idaho. Blazer produces higher yields than Traill and Larker and has greater resistance to shattering and lodging.

Blazer yields in eastern Washington have averaged 500 to 700 pounds higher than Traill and Larker.

Test weight of Blazer is slightly lower than Traill or Larker but plump kernel percent is about the same as Traill. The variety was developed by Washington State University.

Fieldwin

Fieldwin is a bearded, white-chaffed, semidwarf wheat released in 1977. Compared to Twin, grain test weight is nearly 2 pounds per bushel greater, maturity about two days earlier, and height about 1 inch taller. Fieldwin is moderately resistant to powdery mildew and leaf rust and moderately susceptible to stripe rust. Milling and baking qualities are good. Fieldwin was developed by SEA-USDA and the Idaho Experiment Station at Aberdeen, Idaho.

Dirkwin

Dirkwin is a beardless, white-chaffed, semidwarf wheat released in 1978. It is a very widely-adapted variety, yielding well under both droughty and high-producing conditions. Compared to Twin, Dirkwin is similar in plant height, test weight, and heading date. Dirkwin is resistant to powdery mildew and moderately resistant to leaf rust and stripe rust. The milling and baking qualities of Dirkwin are satisfactory. Dirkwin was also developed by SEA-USDA and the Idaho Experiment Station at Aberdeen, Idaho.

Wared

Wared is a hard red spring wheat evaluated and released by Washington State University and SEA-USDA. The original crosses and selections were made by Minnesota as part of the United States Department of Agriculture, Agricultural Research Service, and University of Minnesota wheat research programs. Wared has an awned, white-chaffed head with semidwarf plant-type growth. The variety is slightly earlier maturing than Marfed. Wared has a higher yield record than Peak 72 and has excellent milling and baking qualities when grown on dryland or with irrigation.

Wampum

Wampum is a new "tall" semidwarf hard red spring wheat developed by Washington State University and SEA-USDA. The straw is lodging resistant. Yields are higher than Wared and equal to Fielder under irrigation. It is resistant to leaf and stripe rusts. Wampum has excellent milling and bread baking qualities.

Sawtell

Sawtell is a semidwarf hard red spring wheat developed by SEA-USDA at the Aberdeen, Idaho, station. In Washington, Sawtell has sometimes shown higher yield potential under low rainfall conditions than other hard red spring wheats; however, it was inferior to Wampum in 1978. Under irrigation, its performance has not been exceptional but appears similar to other hard red spring wheats. Under some conditions, it has tended to produce grain of about 1 percent lower protein than other hard red spring varieties. Sawtell is moderately susceptible to stripe and leaf rusts and is moderately susceptible to mildew. In 1978, Sawtell was highly susceptible to both leaf and stripe rusts at Pullman.

Borah

Borah is a bearded, white-chaffed, semidwarf wheat released in 1974. Compared to Twin, grain test weight is about 3 pounds per bushel greater, maturity is five days earlier, and height is about 1 inch shorter. Borah is resistant to leaf and stripe rusts and has good milling and baking qualities.

Karl

Karl is a mid-season, white-kerneled, midwest malting-type barley with rough awns. It averages about 8 percent higher than midwest types. Karl is usually 3 to 4 inches shorter and heads earlier than Traill. It has good test weight and kernel weight. It is slightly superior in shattering resistance.

Although Karl is generally equal to or superior to Traill in agronomic performance under irrigation, it is more susceptible to lodging and shattering than varieties such as Steptoe. It is not well-adapted to production on nonirrigated land in very low rainfall areas. The variety was developed by SEA-USDA and the University of Idaho.

Larker

Larker is a white-kerneled, semismooth-awned, 6-row malting barley. It has moderate resistance to lodging and is high in test weight. Larker yields have been low. It heads earlier than Traill. It is moderately susceptible to the smuts and powdery mildew and resistant to stem rust. It may have some tolerance to barley yellow dwarf virus.

Vanguard

Vanguard is a 2-row malting barley recommended for nonirrigated areas. It has good lodging resistance. Vanguard matures about the same and is the same height as other 2-row varieties. It is a 2-row, spring barley with rough awns. The seed size is slightly smaller than Piroline. The malting quality is slightly below Klages and Kimberly but the yield has been higher on nonirrigated tests.

Klages

Klages is a 2-row malting barley adapted to production with irrigation. The variety is not well-adapted to low-moisture dryland situations. Klages has been classified as acceptable for malting and brewing by the Malting Barley Improvement Association.

Klages has stiff straw and the beards are rough. It is mid-season in maturity.

The variety has excellent malting quality but does not have as high yield record in Washington tests as other 2-row malting varieties. Klages was developed by the University of Idaho.

Kimberly

Kimberly is a 2-row spring malting barley variety released by the SEA-USDA and the Idaho and Oregon Agricultural Experiment Stations. Kimberly has averaged higher yields than Klages and has been similar to Klages in test weight, plump kernel percent, height, and lodging in irrigated trials. It has performed similar to Klages in nonirrigated trials in yield. The variety is mid-season in maturity with long heads that have rough awns. The variety is similar to Klages in malting trials.

Belford

Belford is a 6-row, hooded or awnless variety of spring barley developed by Washington State University. It is mid-season in maturity and medium tall. The straw is relatively weak. Belford is recommended for hay and only in eastern Washington high rainfall areas and in central Washington under irrigation.

Winter Barley

Kamiak

Kamiak is a 6-row winter barley. It has produced high yields in tests. Kamiak has good winterhardiness with large kernels. It is more lodging resistant with short straw. The test weight of Kamiak is high. The variety matures in mid-season. Kamiak does not have small, glume hairs which cause "itching" during threshing.

Kamiak performs well in eastern Washington. Kamiak was developed by Washington State University.

Boyer

Boyer is a 6-row, white-kerneled, winter barley variety with rough beards but it does not have the severe "itching" characteristics of other winter varieties.

The high-yielding, relatively shorter, stiff-strawed barley has a high yield. Boyer is slightly more winterhardy than other varieties except Kamiak. Boyer has shorter straw than the other winter barleys with 15 percent less lodging.

The kernels of Boyer are larger and plumper than other winter barleys. Boyer was developed by Washington State University.

Oats

Cayuse

Cayuse is a high-yielding, moderately early spring oat recommended in Washington. Cayuse was developed by Washington State University from a selection made at Cornell University. It is a short, pale green variety with open and spreading heads. The straw is strong and resistant to lodging. The kernels are light yellow. Cayuse has yielded 10 to 20 percent more than Park in test plantings.

The main weakness of Cayuse is its low test weight compared with that of Park. The test weight of Cayuse has averaged about 35 pounds per bushel in all Washington locations, with 37 for Park.

Cayuse has fair tolerance to the most serious oat diseases in Washington—barley yellow dwarf virus disease, or "red leaf of oats." The yellow dwarf tolerance of Cayuse can be seen mainly in its high-yielding ability. Discoloration results after severe attack by aphids carrying the virus.

No other disease of consequence has attacked Cayuse at any Washington location since testing began in 1959. Cayuse is susceptible to node blackening and stem break in the eastern part of the United States, but the disease does not affect oat yields in Washington.

Appaloosa

Appaloosa is a new yellow spring oat developed by Washington State University with more yellow dwarf virus tolerance than Cayuse. Appaloosa has up to 10 percent higher yield performance compared with Cayuse, but slightly lower average test weight. Appaloosa is a mid-season spring oat with straw 1 to 2 inches shorter than Cayuse. It has slightly better resistance to lodging than Cayuse.

SOFT WHITE WINTER WHEAT IMPROVEMENT

Clarence J. Peterson, Steve Hayward,
Mary Baldridge and Leslie Little
USDA, SEA, AR

General Seasonal Conditions: Washington produced 118,000,000 bushels of wheat on 2,900,000 acres in 1978-79 for a 39.6 bushel-per-acre average. This is 2.9 bushels-per-acre below the ten-year average (1964-73) of 42.5 bushels. Yields were reduced because the winter was very cold and there was very little snow cover. Approximately 28 percent of the winter wheat was killed. Plant vigor and stands were reduced in many of the fields that did not require reseeding. Cereal diseases and insects caused little damage. Barley yellow dwarf was the most important disease.

The 1978-79 nursery at Ritzville was on the edge of the wheat area that was severely damaged by cold weather. We obtained good data on the winter hardiness of the advanced lines and varieties as shown in the following table.

WINTER INJURY AND YIELD (Bu/A) DATA ON 12 WINTER WHEATS GROWN AT RITZVILLE, WASHINGTON IN 1978-79

	% Injury	Yield
NUGAINES	44	43
DAWS	8	52
STEPHENS	82	18
LUKE	43	44
WA6363	26	52
WA6470	16	52
ID745318	9	58
OR680007	30	48
BARBEE	39	49
FARO	54	44
TYEE	14	54
JACMAR	16	60

The winter wheat breeding program in Washington is conducted primarily at WSU's Spillman farm near Pullman, Washington. Off-station testing is carried on at Colton, Pomeroy, Walla Walla, Central Ferry, Lamont, Cunningham, Ritzville, Reardan, Waterville and Puyallup. Nurseries are also grown at Havre, Montana, and Deary, Idaho. Extension yield and observation trials are grown at a number of other locations in Washington. In addition, promising lines are submitted to the Western Regional Soft White Winter Wheat Nursery for evaluation in Idaho, Montana, Utah, Nevada, California and Oregon.

Objective: The objective of the soft white winter wheat program is to develop wheats with the disease resistance and agronomic characteristics needed for production in the Pacific Northwest. The wheats must also have the quality characteristics that are needed for the domestic and export markets.

Promising Selections:

WA 6363 (Luke/WA 5829) is a high-yielding soft white common semidwarf winter wheat. It has resistance to the local races of stripe rust, common bunt and dwarf bunt. WA 6363 is susceptible to flag smut. It has some tolerance to leaf rust and snow mold. WA 6363 matures late and has weak straw. Grain yield of WA 6363 is slightly higher than that of Luke. The milling and flour characteristics of WA 6363 are similar to those of Nugaines. It would be a good replacement for Luke.

WA 6472 (semidwarf multiline club) is a composite of 10 club lines that are resistant to stripe rust. It is more generally adapted to the region than Paha and Faro. Chaff color varies from white to brown. Plant height of WA 6472 is also quite variable. The grain yield of WA 6472 has equaled or exceeded that of Faro and Barbee. Milling and flour characteristics are similar to those of Paha.

WA 6581 (VD76217/VB67297, Sel. VD75211) is a soft white semidwarf club winter wheat that is resistant to local races of stripe rust, common bunt, dwarf bunt, *Cephalosporium* stripe, flag smut and *Cercosporella* foot rot. WA 6581 has generally exceeded the grain yields of Faro and Barbee. Milling and flour quality characteristics of WA 6581 are excellent. It may be too short for production in the 12-18 inch rainfall area.

WA 6580 (CI 14484/K 691533, Sel. VH 75847) is a good yielding soft white semidwarf winter wheat. It is resistant to the local races of stripe rust, *Cephalosporium* stripe and common bunt. WA 6580 is moderately susceptible to leaf rust and is susceptible to dwarf bunt and snow mold. Milling and flour quality of WA 6580 is similar to that of Nugaines.

WA 6470 ((VH 66438/VH 59287/CI 13438)/Norco, Sel. VH 74333) is a soft white common semidwarf wheat that has adult resistance to the local stripe rust races. It is resistant to flag smut and common bunt. WA 6470 is susceptible to leaf rust and *Cercosporella* foot rot. Grain yield of WA 6470 has been a little higher than that of Nugaines and Daws. Its milling and flour quality characteristics are similar to those of Nugaines.

WA 6696 (Daws/WA 5829) is a soft white common semidwarf that is resistant to the local races of stripe rust and common bunt. It has moderate resistance to dwarf bunt. WA 6696 produced 5% more grain than Daws in 1978-79.

WA 6697 (Hyslop/Bruehl 70-254-6) is a soft white common semidwarf that is resistant to the local races of stripe rust and common bunt. It produced 5% more grain than Daws in 1978-79. The milling and flour quality characteristics of WA 6697 are similar to those of Nugaines.

Oregon

OR 680007 (Yamhill/Hyslop) is a soft white common semidwarf that has good stripe rust and common bunt resistance. It was developed by Oregon State University. It equals Luke and McDermid in winterhardiness. OR 680007 has equaled or exceeded the grain yields of Daws and Stephens. It is susceptible to *Cercosporella* foot rot and *Cephalosporium* stripe.

Idaho

ID 745318 (WA 4765//Burt/PI 178383) is a soft white common semidwarf that has good stripe rust, common bunt, dwarf bunt and *Cephalosporium* stripe resistance. It has good tolerance to *Cercosporella* foot rot. It has generally equaled the grain production of Daws. The test weight of ID 745318 tends to be 1 to 2 lbs. lower than that of Daws.

HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson and M. Nagamitsu

The Hard Red Winter Wheat Breeding and Testing programs in Washington are partially funded by the Washington Wheat Commission and are conducted from the Dry Land Research Unit at Lind. Primary emphasis is placed on increasing yields of winter wheats for the 8 to 12 inch rainfall areas by combining the higher yield potential of soft white winter wheats with the better yielding hard red varieties and selections. Crosses are also made to incorporate the desired quality, disease resistance, rapid emergence, winterhardiness and agronomic traits into single lines. Every attempt is made to include a wide genetic background in the breeding program. Different types and sources of disease resistance are used to help prevent having only one source of resistance to any given disease. Many of the sources for disease resistance, winterhardiness, quality, or yield are not well adapted to the area and require one or two series of crosses (parent building) to get the desirable features into adapted varieties of high quality and disease resistance for the low rainfall area.

In 1978-79 severe winter injury and winter kill caused damage to some selections at all nursery locations, extensive damage to all winter wheat nurseries on the experiment station and eliminated the F_1 population and early generation plant rows. Only two selections in the Western Regional White Winter Wheat Nursery and five selections in the Western Regional Hard Red Winter Wheat Nursery yielded as high as spring wheat (Urquie) seeded adjacent to the nurseries. Although selections in the Northern and Southern Regional Hard Red Winter Wheat Nurseries showed less winter injury, their yields were less than spring planted wheat. Spring growth was slow and weak for most winter wheats.

About fifteen advanced and seventy preliminary selections were identified which demonstrated winterhardiness equal to or greater than Wanser. All of the progeny of Cerco (used extensively for *Cercosporella* resistance) showed weak winterhardiness and a very low test weight in 1979 harvest.

The Lind nurseries this year were seeded deep in minimal moisture. Some stand establishment problems are evident, particularly in the Western Regional Hard Red Winter Wheat Nursery. Very little winter damage and essentially no winter kill was evident in any of the Washington selections. In one late seeded nursery received from Oregon, several selections were severely damaged.

Hatton has shown about a 10% yield advantage over Wanser. It has adult resistance to the stripe rust races presently found in the Pacific Northwest. It is white chaffed, stiff strawed, and taller than Wanser with plant and head types similar to Wanser. Emergence, growth habit, and winterhardiness appear to be similar to Wanser. Weaknesses include a lack of adequate resistance to common bunt and foot rot.

Weston, an Idaho State release, has shown to have a slight yield advantage over Wanser in three years of testing. It has good winterhardiness, good stripe rust resistance and some resistance to dwarf bunt and snow mold. No emergence problems have been experienced in the field trials. Weston may be somewhat weak on quality.

Some agronomic characteristics of recommended varieties and the older varieties they replace are given for four locations in Eastern Washington in Table 1, Harrington (Robert Kramer); Table 2, Lind; Table 3, Finley, (Richard Deffenbaugh); Table 4, Horse Heaven Hills, (Bayne Farms). The nurseries at Connell and Waterville were not harvested. These data are from rod row nurseries.

Table 1. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row nurseries, 1952-79.

Variety	Av. Test wt.	1979 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.0	46.0	40.1	134	14
Luke	61.1	44.8	41.4	140	11
Sprague	61.4	51.4	44.1	140	9
Daws	60.8	51.5	42.3	132	6
Stephens	59.4	44.9	41.7	130	6
Moro	59.3	46.2	39.2	131	14
Paha	60.6	49.7	41.1	140	12
Tyee	59.3	54.7	45.4	146	4
Barbee	59.1	48.4	45.3	136	7
Faro	59.8	50.1	42.4	132	6
Wanser	62.4	43.4	38.6	130	13
McCall	62.9	47.0	41.5	141	12
Hatton	63.9	50.2	38.9	131	4
Kharkof	61.3	36.3	34.1	100	26

Table 2. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries, 1952-79.

Variety	Av. Plant ht.	Av. Test wt.	1979 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.2	18.8	37.1	128	15
Luke	25	59.6	9.8	32.7	124	11
Sprague	27	60.2	21.5	33.0	130	9
Daws	30	58.6	23.4	34.5	132	6
Stephens	29	57.7	4.0	30.5	122	7
Moro	30	58.5	18.8	35.8	121	16
Paha	27	59.6	12.2	36.5	131	13
Faro	28	57.0	15.6	36.3	117	6
Tyee	26	58.0	16.8	31.7	102	4
Barbee	26	57.9	15.2	35.0	134	7
Wanser	31	61.7	19.5	33.9	114	16
McCall	31	61.8	23.1	36.3	121	15
Hatton	31	62.4	23.5	31.5	143	4
Weston	37	60.8	25.6	30.1	146	2
Kharkof	33	60.5	16.7	29.2	100	25

Table 3. Summary of agronomic characteristics of winter wheat varieties at Finley in rod row nurseries, 1975-79.

Variety	Av. Test wt.	1979 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	63.0	33.0	31.9	119	5
Daws	61.2	37.6	32.4	134	4
Stephens	59.7	32.5	29.6	122	4
Moro	59.8	35.5	36.2	135	5
Faro	60.1	38.7	33.2	137	4
Barbee	60.3	36.7	27.4	133	3
Wanser	63.1	35.1	29.4	110	5
McCall	63.3	37.0	30.5	114	5
Hatton	63.9	36.8	32.8	135	4
Weston	61.5	37.7	37.7	134	1
Kharkof	61.7	28.1	26.8	100	5

Table 4. Summary of agronomic characteristics of winter wheat varieties at Horse Heaven Hills in rod row nurseries, 1951-79.

Variety	Av. Test wt.	1979 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	60.1	9.2	18.4	117	9
Daws	58.9	10.2	11.5	95	4
Stephens	57.7	8.1	13.0	107	4
Moro	57.1	10.4	17.4	115	11
Faro	57.2	9.5	11.3	93	4
Barbee	56.8	10.5	8.9	86	3
Wanser	60.2	13.5	18.1	116	12
McCall	60.8	15.6	18.0	115	12
Hatton	62.3	11.9	11.9	99	4
Weston	61.5	16.4	16.4	122	1
Kharkof	60.0	13.4	17.1	100	19

SPRING WHEAT IMPROVEMENT*

C. F. Konzak, M. A. Davis, M. R. Wilson

The spring wheat research in Washington is conducted utilizing mainly the research facilities at Pullman (medium rainfall), Lind (low rainfall), and Royal Slope in the Columbia Basin (irrigated), with off station regional research trials via grower cooperation near Connell, Dayton, Harrington, the Horse Heaven, Pomeroy, Walla Walla and Waterville. Extension observation trials are conducted at these and a number of other locations in the wheat growing areas of Washington. New introduced varieties, lines, and plant selections are also being tested in preliminary nurseries, with each entry being evaluated at all three main locations during the same year. By this method it is possible to more quickly estimate the probable adaptation and potential of varieties and lines and to select those that warrant further and wider testing in the off-station trials.

The general scope of WSU spring wheat research is indicated by Table 1 which lists the trials and numbers of selections under evaluation in 1979 and 1980. Among the nurseries grown at the three station locations, several can be seen by those attending the field days, including the Regional Facultative Wheat Nursery and the Western Regional and Washington State Uniform Wheat Nurseries. The Midwestern Uniform Regional Hard Spring Wheat Nursery and the International Spring Wheat Nursery (CIMMYT) are evaluated first at Pullman and sometimes with observation plots at Lind, if seed supplies are sufficient. The main crossing blocks and parental lines are grown at Pullman. All new crosses are made at Pullman because of the more favorable conditions for crossing and regular adaptability of new parental sources. Many new foreign introductions and other new germ plasm sources are evaluated and some used in crossing each year.

Objectives: Major emphasis in breeding and selection continues to be yield performance for specific and general conditions, with crosses being made to incorporate the necessary quality, disease resistance, cold tolerance (facultative characteristics), and desirable agronomic traits into adapted lines. Research to improve the potential for higher protein content and nutritional value of hard red wheats is receiving increased attention as is research on a dual purpose quality type. Preliminary single plot and replicated yield tests of some higher protein derivative hard spring wheat from crosses of local wheat with Argentine and other introductions are included in the 1980 research at Pullman and Royal Slope.

The 1980 Western Regional, Commercial Variety and Washington State Soft White and Hard Red Spring Wheat Nurseries include new entries from the Washington State cereal research program and from the States of California, Idaho and Utah and/or promising new entries from private breeders.

One of the major disease problems affecting estimates of yield potential in tests under irrigation, Barley yellow dwarf virus, may have been placed under control via sprays with systemic insecticide. Yields in 1978 on some lines exceeded 120 bu/acre at Royal Slope. Many durums yielded over 125 bu/acre. Planting of the 1979 trials there was delayed about four weeks due to the delayed experimental drill construction. However, many lines yielded in the 100+ bu/acre range.

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*Grower input of financial support via the Washington Wheat Commission for spring wheat improvement has made possible many of the advances in spring wheat breeding described herein.

The situation with stripe and leaf rusts already predicted from 1977 data, was more severe than expected in 1978, but in 1979 little rust developed. May 1978 plantings of Fielder and Fieldwin types became 100% infected with the new stripe rust race at Pullman, and showed approximately 40% yield reduction. Urquie, Walladay and WS-1, as well as most WSU selections showed good resistance to stripe rust. The new leaf rust also was abundant in 1978, and while Fielder may have some resistance to this race, stripe rust infections took priority on available leaf space. Of the soft white cultivars only WS-1 showed moderate resistance. Moreover, even in the Advanced Washington State and Western Regional trials only one of the soft white entries WA6402 showed moderate resistance to both rusts. WA6402 has shown only average yield performance in other years, but has had sufficient testing to permit consideration as a potential stopgap variety. Its performance in 1979 was generally good. Therefore, plants for potential breeder seed production will be selected in 1980.

The serious rust problem has resulted in some major adjustments in the WSU program. All new WSU-developed state and regional entries now carry resistance to both rusts. These entries were selected from among promising lines from single plot tests in 1978, evaluated for quality trials and increased over the 1978-79 winter season in New Zealand via the cooperation of a local plant breeder there.

The new rust races pose a serious threat to soft white spring wheat production in the area, since nearly all of the winter wheats grown are highly susceptible to at least the leaf rust disease and provide inoculum to infect the spring wheats. A crash program effort was initiated to identify new resistance. The 1980 plantings reflect the results of that effort. The crash program tests in 1972-78 showed that a large portion of very promising new high yielding selections from WSU, Idaho, and Oregon were susceptible to the new leaf rust race. Nevertheless, a number of resistant WSU lines have been identified. New crosses made in the greenhouse already incorporate new resistance sources identified in the fall of 1977, and in 1978. A winter 1977-78 increase in Chile of F_4 material from several crosses advanced new breeding lines into the selection stage. A winter 1978-79 increase of over 1000 new selections was made in New Zealand, with the result that many rust resistant good quality selections could be included in the 1979 regional trials, and in adaptation tests. The best of these lines are included in the 1980 regional and replicated advanced trials.

One of the new disease resistant soft white wheat lines (WA6619) advanced because this winter increase showed outstanding agronomic performance in 1979; it has satisfactory pastry quality. Plants will be selected in 1980 toward a potential breeder seed increase.

New Quality Development. A totally new combination of quality traits appears to have been achieved in a number of WSU soft white spring and facultative wheat lines. This new quality type combines the processing characteristics (bread and pastry properties) of typical hard red wheats with those of the common soft white wheats. With wheats having this combination of traits, Washington growers could have access to a wider selection of market channels, and compete more effectively with Australia for Asian markets, as well as in U.S. specialty markets.

These wheats also should offer advantages to the PNW market in their suitability and blendability at all protein contents. Small pilot scale tests of lines having the new quality type are in progress and larger scale tests are planned for 1980-81. Some of the new dual quality wheats show competitive yield performance with current soft white spring wheats, but have inadequate disease resistance. Other new lines have disease resistance, but yield testing has just begun. Numerous new cross combinations have been made and more will be made to study the inheritance and recombination of the new trials.

Recent Variety Developments

Soft White Spring and Facultative:

URQUIE—Developed at Washington State University with cooperation of USDA-SEA and released by Washington and Idaho in 1978 as a replacement for Marfed. This new high milling and baking quality common soft white semidwarf spring wheat variety carries an effective adult plant type of resistance to stripe rust. Urquie also produces better test weight grain than Twin under all cultural conditions. Earlier tests indicated that Urquie was better adapted to the low rainfall areas than either Fielder or Twin. Tests indicate that Urquie will perform as well as Twin and Fielder in the higher rainfall areas and under irrigation, while retaining its superiority in the low rainfall area.

The greater cold tolerance of Urquie compared with Marfed, Twin and Fielder should permit earlier spring planting which is desirable for achieving highest yields. A good supply of registered and certified seed was available via WSCIA for 1980 planting.

WALLADAY—Increased in 1977 as WA6153. This semidwarf, facultative soft white common spring wheat was released in 1978. Walladay carries resistance to some races of leaf rust and is moderately to highly resistant to stripe rust, including the races that severely attacked Fielder and Fieldwin in 1978. Its quality is similar to Fielder. Performance tests to date indicate that Walladay has equal to greater yield potential than Fielder. Its later maturity than Twin or Fielder may permit higher yield potential under irrigated culture, but may be a disadvantage in late spring plantings. However, it has done well in moderately early plantings in the dryland area. Walladay has greater cold tolerance than Urquie and may be suitable for late fall and midwinter and very early spring seedings in areas where this practice may be desirable or necessary due to severe freezing injury to winter wheats. Small foundation and additional breeder seed stock increases were produced in 1978. However, the stripe rust resistance of Walladay may not be adequate for fall seeding in areas of heavy stripe rust attack, as in Western Washington, and a new race of leaf rust, which also attacks Urquie, Dirkwin and Twin, may be especially damaging on late spring planting crops. The 1979-80 winter nearly killed out Urquie, and injured Walladay at Pullman, while Nugaines and standard winter wheats were comparatively little affected, indicating that a greater level of cold hardiness is needed for the Pullman area. Its survival was good at other Southeastern Washington locations.

Hard Red Spring Wheats:

WAMPUM—Formerly WA6105, developed by Washington State University with USDA-SEA cooperation, is a short standard height stiff-strawed hard red spring wheat with good milling and baking properties. Wampum tends to be better adapted to higher rainfall and irrigated culture than other hard red spring wheats and may find its widest use in that area except when needed for overplanting injured hard red winter wheats. Wampum appears to carry different types of resistance to stripe and leaf rusts than other hard red spring varieties now in production. It is also resistant to powdery mildew. Foundation and registered seed were produced in 1978. Wampum carries high resistance to the new stripe rust races, adult plant resistance to local leaf rusts and may carry tolerance to barley yellow dwarf virus. Wampum achieved the overall highest yield record among wheats tested in Washington State trials in 1978. It generally was a high producer also in 1979.

Durum Wheat:

WAID—Formerly WA6292, was developed by Washington State University and released jointly in 1980 by Washington and Idaho experiment stations. Waid offers both a yield potential advantage over Wandell and distinctly better marketing quality, i.e. larger kernels and lower berry (higher % vitreous). Waid is expected to replace Wandell and offer irrigated wheat growers an economic alternative to soft white and hard red wheats. Waid is highly resistant to the rust diseases and moderately resistant to mildew.

Table 1. Research Trials and Number of Selections Under Test in WSU Research

Nurseries	Coordinator	1979 Locations	1980 Locations	1979 Entries	1980 Entries
Western Regional Spring Wheat Nursery	USDA-MT	25(3)	25(3)	36	36
Western Facultative Wheat Nursery	WSU	12(6)	12(6)	12	12
Tri-State Spring Wheat Nursery (WA, ID, OR)	WSU	6(3)	7(3)	36	
Uniform Regional HRS Nursery	USDA-MN		(1)	(1)	
International Spring Wheat Yield Nursery	CIMMYT-Mex	60(0)	60(1)	50	50
International Durum Yield Nursery	CIMMYT-Mex	27(1)	27(1)	25	25
Western Durum Nursery	WSU	5(1)	4(1)	36	30
International Durum Crossing Block		12(1)	12(1)	150	200
International Spring Wheat Observation Nursery	CIMMYT-Mex	60(1)	60(1)	300	300
International Winter/Spring Wheat Observation Nursery	CIMMYT-OSU	50(1)	50(1)	250	250
Northwestern States Oat Nursery	USDA-ID	16(1)	16(1)	28	28
WSU RESEARCH TRIALS—					
Commercial Variety Nursery	WSU	(5)	(5)	32	32
Washington State Regional SWS		(9)	(9)	33	33
Washington State Regional HRS		(6)	(6)	27	27
WSU Advanced Trials (2nd season rep)		(3)	(3)	80	100
WSU Preliminary (1st season rep)		(3)	(3)	260	300
WSU Single Plot		(1)	(1)	4000	4000
F_4 F_5 Single Row Evaluations		(1)	(1)	30000	30000
F_3 Bulks		(1)	(1)	300	300
F_2 Bulks		(1)	(1)	350	400
High protein lines (rep)		2	(3)	70	60
		——	2	———	75

(   ) Number of Washington State Locations

TRI-STATE SPRING WHEAT NURSERY

C. F. Konzak

The plant breeders in the three Northwest states cooperating on variety releases interchange advanced lines of spring wheats for preliminary regional tests one season before the best performing lines become candidates for entry into the Western Regional Spring Wheat Nursery. The Tri-State Spring Wheat Nursery thus serves to provide wider scale tests on a larger number of promising lines than would otherwise be possible, and increases the possibility that those selections finally entered in the wider regional testing program will have variety potential for the Tri-State area.

COMMERCIAL VARIETY NURSERY

C. F. Konzak, M. A. Davis, and M. R. Wilson

Beginning in 1976, a new set of trials was established by WSU to evaluate promising new material developed by private plant breeders which would likely be produced for sale in Washington State. We invited private breeders to send us their advanced lines and current varieties for inclusion in these tests.

The 1980 nurseries include selections from four private breeding firms, North American Plant Breeders, Northrup King, Western Plant Breeders, and World Seeds. Growers attending Field Days at any of the three main stations (Pullman, Lind and Royal Slope) and at Harrington will be able to observe and compare private as well as publicly developed wheats in this trial.

IMPROVING PROTEIN CONTENT AND NUTRITIONAL COMPOSITION

C. F. Konzak

Crosses made several years ago using germ plasm sources obtained from the Nebraska-USAID program and from several other sources have advanced to the stage where lines with potential for significantly increased contents of protein or dibasic amino acids (including lysine) have been identified. Some preliminary selections are now being tested for performance, stability and adaptation in replicated trials at the three main stations. Other selections are being increased to permit confirming tests and wider evaluation while the best materials will be used as parents in further crosses.

Generally, the high protein germ plasm sources have been poorly adapted for local conditions and have poor processing, hence the early crosses have had little potential. Thus, several breeding cycles may be necessary to exploit the potential of these materials in developing competitive or higher yielding locally adapted varieties.

We now have identified selections with ability to produce a high content of protein and/or probably more nutritious protein in the flour, as well as a few that from preliminary processing tests show promise for mixing and potential baking properties. Preliminary yield data from 1979 indicate that several of the lines also may yield competitively with current spring wheat varieties, thus they produced more protein per acre than the standard hard reds. Considering the increased costs of N fertilizers, and the potential for greater assurance that protein levels in harvested grain will meet market requirements, the progress made to date is encouraging.

WESTERN REGIONAL AND WASHINGTON STATE SPRING WHEAT NURSERIES

C. F. Konzak, M. A. Davis, M. R. Wilson
K. J. Morrison, P. E. Reisenauer, E. Donaldson

This cooperative research test of the performance potential and adaptation of spring wheats usually includes 25 to 36 entries, some soft white, a few hard white and a high proportion of hard red spring wheats. The nursery is grown at about 25 locations throughout the West, ranging from Canada to Arizona including the Washington stations. WSU's 1980 entries include nine soft white and three hard red spring selections.

The Washington State Soft White Spring and State Hard Red Spring Wheat Regional Trials are grown at the three main stations. Either or both are also grown on sites provided by farmer cooperators. The standard commercial varieties and promising advanced 'near varieties' are included in all county extension trials of spring wheats in the state.

DURUM WHEAT IMPROVEMENT

C. F. Konzak and M. A. Davis

There is potential for a small, but significant acreage of durum wheat production especially in the irrigated Columbia Basin of Washington and Oregon. WSU tests have consistently proved that grain of acceptable to high processing quality can be produced in Washington, and that yields can be competitive with soft white or hard red spring wheats. The variety Wandell, the first U.S. semidwarf durum, was developed by WSU in an effort to provide local irrigated growers access to the area markets for durum. While performing well agronomically, Wandell has a quality weakness in its tendency for producing grain high in yellow berry, a condition that reduces the market grade and thus income to the grower. Because durum must be handled as a separate, specialty or contract crop, this weakness has been serious. Central Washington growers of durum now have reasonably close access to the General Foods mill in Pendleton besides the Portland outlets, providing a ready market for this crop. Thus a new variety is needed to permit irrigated growers an alternative to soft white wheat. WSU has carried on a small, but effective breeding and selection program for a number of years, and coordinates the Western Durum Nursery trials. Tests of CIMMYT's International Durum Nursery also are conducted at the Royal Slope farm. Based on results from five years' trials in the Western Durum Nursery, one WSU line, designated WA6292, has shown outstanding performance and advantages over Wandell in both Washington and Idaho tests. It not only has equal to or better yield than Wandell, but also has larger kernels and low yellow berry (a high tendency to produce vitreous grain) as desired by the industry. WA6292 is currently undergoing a Foundation seed increase, and is being released cooperatively by the Washington and Idaho experiment stations under the name WAID.

BARLEY BREEDING AND TESTING PROGRAMS IN WASHINGTON

R. A. Nilan, C. E. Muir, S. E. Ullrich
K. J. Morrison and P. E. Reisenauer

The overall objective of the barley improvement program in the State of Washington is the development of high yielding, stiff-strawed agronomically acceptable varieties that are adapted to the different barley producing areas of Washington and that have superior malting and nutritional quality. When winter grown, they must have winterhardiness superior to the current winter barley varieties. This objective includes the development of "multipurpose" varieties that will be the highest yielding varieties available. Such varieties, whether 2-row, 6-row, spring or winter, will have quality that will meet malting industry standards and because of their malting quality they should be superior in feed quality. Thus, they will meet all market demands for barley grown in this state.

The program involves the development of winter and spring, 2-row and 6-row multi-purpose varieties at Pullman, selection and testing programs at Lind (dry land) and Davenport (winterhardiness), and testing programs at Royal Slope (irrigated), Walla Walla, Dayton, Pomeroy, Vancouver, Puyallup and Mount Vernon.

The new varieties developed within WSU's barley breeding program are described in the front of the brochure under recommended barley varieties for the state of Washington. Representative results of the performance of these varieties in tests at Pullman are summarized in Table 1. This table also includes some advanced selections which will be discussed below.

6-row Spring

WA 6591-69 was released in the spring of 1979 under the name 'Advance.' Its agronomic characteristics are described in the front of the brochure under recommended barley varieties for the state of Washington.

Advance was released without designation of its malting status. Industry plant scale testing for malting and brewing acceptability on a 1978 crop carlot has been completed and one is underway on the 1979 crop in much larger quantities. Results of the tests are very encouraging thus far, and its malt analytical properties are similar to Larker, the 6-row standard of quality.

Advance was tested for nutritional quality and was judged to be superior to Steptoe and equal to the best 2-rows in nutritional value.

2-row Spring

The next 2-row malting variety will be released within the next three years and will come from three selections involving Klages crosses. These selections (Table 1) have undergone initial plant scale malting and brewing tests. These selections are higher yielding than Vanguard, Klages, or Kimberly, yield 90-95% of Steptoe, and have the quality of Klages. Release of one of these will reestablish the Palouse area as a major 2-row malting producing area, a market usurped by the superior qualities of Klages and Kimberly grown under irrigation in other areas.

Winter Barley

The new variety Boyer performed beyond expectations in 1978, its first year of commercial production, with some yields reported up to four tons per acre. The severe winter of 1978-79 was generally devastating to winter barley, but survival this past winter was quite good. Winter survival data for this past winter at Pullman and Davenport is presented in Table 2. The long term average survival for Boyer, Kamiak and Luther is also present. The severe site at Davenport, as usual, allowed for a good determination of winterhardiness.

All new winter 6-row and 2-row selections are of the "multipurpose" type, i.e., high yield, suitable malting and feed quality. No selections are as advanced as those of the spring types, chiefly because these selections must also be winterhardy. More progress has been made with the 2-row than with the 6-row.

Field Days

Visitors at Lind will see a number of the previously described varieties and selections (Table 1) in spring nurseries. Differential winter barley survival occurred, but some of the differences were confounded by poor stand establishment in the fall.

Visitors at the Field Day at Pullman will have an opportunity to view in demonstration plots early and late seedings of 16 current varieties and new advanced selections of spring 6-row and 2-row and 16 current varieties and new advanced selection of 2-row and 6-row winter types.

Table 1. Comparative Yields of Barley Varieties and Types
Pullman, 3 Year Average 1977-79 (lbs. per acre)

Spring		Winter	
		6-Row	
Feed		**Feed**	
Steptoe WSU	4805	Boyer WSU	5803
Unitan	4066	Kamiak WSU	5746
		Luther WSU	5381
Malting		**Malting**	
Advance	4214	Under Development	
Blazer WSU	4037		
Traill-Larker Type	3250		
Karl	3523		
		2-Row	
Malting		**Malting**	
WA 9691-75	4454	Under Development	
WA 9037-75	4118	Sel. 2464-70	4860
WA 9044-75	4118	Ackerman's 989	4697
Vanguard WSU	3782	WA 1623-75*	4405
Piroline	4267		
Kimberly	3739		
Klages	3725		

*1977-78 data only.

Table 2. Winter Survival (%)

	Winter of 1979-80		1971-79
	Pullman	Davenport	Pullman
Boyer	85	40	92
Kamiak	100	40	93
Luther	100	65	93
WA 3435-77	90	60	
WA 1623-75	92	15	

TRITICALE

Clarence J. Peterson, Steve Hayward,
Mary Baldridge and Leslie Little
USDA-SEA-AR

Triticale lines were obtained from CIMMYT, Alabama A&M University, Oklahoma State University, Oregon State University, Eucarpia and Jenkins Foundation for testing in the Pacific Northwest. Each year the new triticales obtained from other programs have shown that improvement is being made in the development of fertile, high-yielding triticales. New lines from our program are also showing improvement. Winterhardiness and kernel development still need considerable improvement. Most of the triticales are too tall and may lodge. Some of the new short selections have performed better than the tall types.

Over 50 new crosses were made in 1979. These include both triticale by triticale crosses and wheat by triticale crosses. A number of new lines were selected for preliminary yield testing during 1979-80. These lines had improved fertility and winterhardiness.

Many of the triticales tested in 1979 produced more grain than the winter or spring checks. The 1978-79 winter was very severe and a number of the triticales were either killed or at least injured. Test weight (lbs/bu) of the triticales is about 10 pounds less than that of wheat but the protein content is 2-3 percentage points higher. The triticales head about 5 to 7 days earlier than winter wheat but they mature about the same time.

Palouse and VT75229 (tables 1 and 2) are the best triticale that we have grown over a number of years. Palouse was developed by Charlie Jenkins and we developed VT75229. Under some environmental conditions we still have some sterility problems with them.

Table 1. Data on triticales and winter wheats
grown at Pullman, Washington in 1977-78
(Planted 9/27/77)

	Heading	Plant Height (inches)	Test Wt. (lbs/bu)	Yield (bu/A)	Yield Range (5 rep.)
Nugaines	6/9	37	50.9	87	70-99
Palouse	5/26	52	50.0	75	52-95
MY20	6/7	37	50.0	84	69-105
Daws	6/9	39	51.3	87	65-100
VT75229	5/26	52	49.1	83	53-97
MY13	6/5	35	47.9	90	85-105
VT76370	5/30	51	49.6	85	69-96

Table 2. 1978 spring triticale yield
nursery grown in Pullman, Washington

	Test Wt. (lbs/bu)	Yield (bu/A)	Yield Range
Fielder	49.6	38	34-44
Palouse	44.9	46	37-56
VT75229	46.0	52	37-63
Urquie	49.9	47	35-53
MT76008	42.2	52	48-56
VT77895	45.1	58	52-69

OATS IMPROVEMENT AND VARIETY EVALUATION

C. F. Konzak, M. A. Davis,
K. J. Morrison, P. E. Reisenauer

Oats remains an important crop for many growers in spite of the overall trend toward reduced acreage planted in the PNW and other parts of the U.S. The potential for high oat yields is exceptional in the PNW, and current varieties have good disease resistance and high yield potential. Varieties Cayuse and Appaloosa are now abundantly available. Their main weakness is low test weight. A recent Idaho release, Corbit, is almost as high yielding and has slightly higher test weight, but has greater tendency to shattering. Newer lines in final evaluation stages offer promise for equal or improved yield potential with higher grain weight. The hull-less variety Terra offers promise for special feed uses by growers able to feed their own production.

BREEDING, DISEASES AND CULTURE OF DRY PEAS AND LENTILS

F. J. Muehlbauer, J. L. Coker, and R. L. Short
USDA-SEA-AR

Dry pea and lentil research is conducted in the Palouse area of eastern Washington and northern Idaho and in nearby irrigated areas. New lines, cultivars and breeding populations are tested in these areas to identify plant types with multiple pest resistance, stress resistance, yielding ability, and quality. The principal areas of research in each of these crops is as follows:

Peas: Root diseases of peas caused by a complex of several organisms are the major reason poor pea yields have been common to the area. Most of our efforts the past few years have been in identifying resistant lines for use as parents, hybridizing the resistant lines with commercial cultivars, and screening the resulting populations for root rot-resistant segregants with good plant type and adaptability. Two green pea varieties, 'Garfield' and 'Tracer,' were released in 1976. Yield tests showed that Garfield, a large-seeded selection, out-yields common 'Alaska' by over 15%.

Garfield is resistant to *Fusarium* wilt race 1, is larger seeded and has a longer vine habit when compared with most Alaska strains. The increased plant height improves harvesting ease, especially on ridges where poor vine growth has been a problem. Garfield does not differ from Alaska in resistance to seed bleaching, powdery mildew, or mechanical damage resistance. Garfield flowers at the 14th node and has tolerance to pea root rot, two factors which delay maturity about one week when compared with most Alaska strains.

Tracer is a small-sieve Alaska type that has yielded nearly 45% more than other small-sieve types. Other major improvements of Tracer over common, small-sieve Alaska strains include more uniform seed size, shape, and color; greater plant height; a lower susceptibility to seed bleaching; and resistance to *Fusarium* wilt race 1. The increased height of Tracer improves harvesting ease on the ridges where poor vine growth has been a problem. Tracer tends to set triple pods at one or more of the reproductive nodes. The need for a small-sieve variety resistant to *Fusarium* wilt race 1 was apparent in 1973 when it was shown that many small-sieve strains were susceptible. The release of Tracer should fill this need and also offer needed yield improvement.

Resistance to pea root rot in Garfield and Tracer is responsible for their improved yields and also may be a factor in stabilizing dry pea production from one year to another and from location to location within a given year. We are hoping to identify breeding lines that show additional yield improvements over Garfield and Tracer in 1980 and more emphasis is being placed on quality factors, especially for resistance to seed bleaching and adaptability to reconstitution. Pea line WA510104 was about equal in yield to Garfield and Tracer from 1976 to 1979 but was earlier maturing and was very resistant to seed bleaching. WA510104 has a semidwarf determinant growth habit, blooms in the 11-12th node, and is double-podded. The line is being proposed for release this year.

WA510287 is a yellow pea selection that has a strong tendril habit that should improve lodging resistance. It was slightly smaller in seed size and slightly later blooming than Latah, but tends to be earlier maturing than Latah. The strong tendril habit of WA510287 should improve resistance to foliar disease especially sclerotinia white mold.

Pea seedborne mosaic virus has caused problems in our breeding program and is a potential serious threat to both dry peas and lentils. Because of the obvious threat this virus poses to the industry, we are incorporating resistance to the virus into the major pea varieties grown in the region. These varieties include five dry peas, ten freezer and canner peas, and one Austrian winter pea. We have made the fourth backcross and plan to release the resistant material in 1980. The virus-resistant derived varieties will be a means of preventing new outbreaks of the disease.

It has been known for some time that pea seedborne mosaic virus will also attack lentils and is seedborne in that crop. Immunity to the virus was identified in the Plant Introduction collection, and is inherited as a single gene recessive. Incorporation of the resistance into commercial lentils is underway.

Preliminary selections are screened for resistance to powdery mildew at Pullman. Natural infections obtained by planting late in May have reached epidemic proportions at about bloom. Lines showing resistance to mildew are increased and evaluated for agronomic characteristics, especially yield, and are used as parental material.

Lines with pea seed weevil-resistant parentage that showed resistance to *Fusarium* wilt race 1 are being evaluated in cooperation with the University of Idaho in 1980 for resistance to the insect. Hopefully, agronomically acceptable lines can be identified and used as a control measure for the insect or to effectively reduce the percentage of infestation. Work is also underway to control the pea leaf weevil through development of resistant cultivars. Resistance or tolerance to the leaf weevil is associated with vigorous plant types with high leaf area.

Lentils: Susceptibility to heat and drought during the critical bloom and pod setting periods seems to be a major factor limiting yields of spring lentils in the Palouse area. Two lentil selections (LC711981 and LC071952) and 'Laird' were compared to 'Redchief' and 'Chilean' in 1979. LC711981 was slightly larger than Chilean and had yellow cotyledons. Laird, a Canadian variety, had the lowest mean yield over the four locations, probably because of its late flowering habit. Laird could possibly be successfully grown in the Palouse area if it was seeded before mid-April. If planted early, Laird would still be slightly lower yielding and mature about 1-2 weeks later than Chilean; however, these disadvantages might be offset by its improved seed size, shape and color. As expected, Redchief was slightly higher yielding than Chilean, presumably because of its resistance to heat stress.

Other studies underway on lentils include the development of heat stress resistant lines and the development of winter hardy types with acceptable seed quality.

Chickpeas: Chickpeas (Garbanzos) are grown throughout the world in similar environments as lentils. It seems from this that chickpeas can be developed as a crop in the Palouse region provided that adapted cultivars and cultural methods are identified. We have obtained a number of cultivars and breeding populations of this crop and are making preliminary tests in 1980 of their yielding ability and adaptation to the area. Dates of planting and seed treatment studies are also being conducted. All indications are that Chickpeas can be developed as a successful crop in the Palouse region.

OILSEEDS AS ALTERNATE CROPS IN EASTERN WASHINGTON

S. E. Ullrich, K. J. Morrison, P. E. Reisenauer and M. F. Ramsay

Several variety trials and cultural studies with oilseed crops were initiated last year in eastern Washington primarily on dryland sites. With the ever present interest in alternative crops and the trend of increasing commercial acreage of sunflower and safflower, these studies were aimed at determining the potential of these crops under eastern Washington's varied conditions, identifying the the adaptability of available varieties and determining the cultural practices that produce maximum yield. This work is part of a cooperative effort among researchers in Washington, Idaho and Oregon supported in part by the Pacific Northwest Regional Commission and Washington Agricultural Experiment Station appropriated funds.

1979 Studies and Results

Sunflower

Test sites in 1979 included the Spillman Agronomy Farm at Pullman (hillside), the Ken Parks Farm at Fairfield (flat-recrop), the Marvin Repp Farm at St. John (flat-recrop) and the Dryland Research Unit at Lind. Sunflower at Lind received supplemental irrigation, while all other trials were grown under dryland conditions. The sunflower varieties involved in the studies were of the hybrid oilseed type, which has experienced the greatest demand and interest. The data in Table 1 as representative of the results in general indicated that sunflower was well adapted to the sites tested as compared to upper Midwest (N. and S. Dakota and Minnesota) performance of yield and oil content. The yields at Lind (supplementally irrigated) were suppressed mainly due to a severe sunflower moth infestation and subsequent head rot problem.

A sunflower seed size experiment conducted cooperatively with the University of Idaho showed that the size of seed planted had relatively little effect on the agronomic performance of sunflower for grain or forage. Therefore, it appears growers should not buy higher priced larger seed if cheaper smaller seed is available.

By studying the effect of planting date and plant population on sunflower growth and development, it was found that effects were variable depending upon location. Also, different varieties responded differently depending upon their maturity. In general, earlier plantings (early May) outyielded later plantings (past June 1) and plant population differences were compensated for by the different components of yield.

Major pest problems in the sunflower in 1979 included the sunflower moth, *Rhizopus* head rot and birds.

Safflower

Safflower yielded reasonably well at Pullman and Lind and exceptionally well at St. John for a spring crop, and oil percentages were quite good in general, as indicated by the data in Table 2. The data represented in Table 2 were selected from the results of a larger trial grown at Pullman, St. John and Lind. Other than weeds, no real pest problems occurred in the safflower trials.

1980 Studies

Sunflower

Investigations are continuing on the effect of planting date on the performance of sunflower at Lind, St. John and Pullman under dryland conditions. At Lind a comparison of deep furrow and conventional double disc planting is being made. The Sunflower National Performance Trial was planted at Pullman. An experiment is being conducted cooperatively with the University of Idaho at Lind to study the incidence and control of sunflower moth.

Safflower

The effect of seeding rate on safflower performance is being investigated at Lind, St. John and Pullman under dryland conditions. Superimposed on these treatments at Lind and Pullman is a comparison of deep furrow and conventional double disc planting. A 10 variety yield trial is being conducted at Lind, St. John and Pullman.

Table 1. Performance of four hybrid oilseed sunflower varieties averaged over trials at several eastern Washington locations, 1979.

Variety	Yield			
	Pullman	Fairfield	St. John	Lind
	lb/a			
Hybrid 894	1610	2128	2892	1298
DO 704	1449	2032	2872	1462
Sungro 372A	2225	—	2396	851
Master Farmer 600	1000	2129	—	—
Averages	1571	2096	2720	1204

	Oil Content			
	Pullman	Fairfield	St. John	Lind
	%			
Hybrid 894	48.4	41.6	45.7	40.6
DO 704	43.7	41.4	45.6	40.0
Sungro 372A	46.2	—	47.3	40.7
Master Farmer 600	—	41.9	—	—
Averages	46.1	41.6	46.2	40.4

Table 2. Performance of five varieties of safflower grown at several eastern Washington locations, 1979.

Variety	Yield			Oil Content		
	Pullman	St. John	Lind	Pullman	St. John	Lind
	lb/a			%		
UC-1	1617	2366	853	38.6	42.8	42.1
S 317	1476	3135	742	42.7	46.4	45.6
UC 14-5	1213	2580	946	35.1	37.1	37.3
S 208	1378	2506	916	40.3	43.5	43.7
S 112	1230	2689	846	41.5	43.4	43.8
Average	1383	2655	861	39.6	42.6	42.5

BREEDING WHEATS FOR CONSERVATION TILLAGE

R. E. Allan, A. J. Ciha and C. J. Peterson
USDA-SEA-AR

This season makes our fourth year for testing diverse wheat genotypes and populations for adaptation and yield potential under conservation tillage. Fortunately we have some of the best trials we have yet conducted this year. Although we are still far from knowing all the answers there are some definite patterns that are becoming apparent in this very complex problem of breeding wheats for production under no-till.

Here is what our results indicate:

1. No single plant type seems best adapted to no-till after grain. Rather an array of plant types can be exploited including a range of plant height levels and market classes.

2. Medium early types appear to have some advantage. We have learned that no-till can often delay heading of wheat. This delay may be as much as 4 days in varieties like Stephens and Brevor, 3 days for Daws and Nugaines but only 2 days or less in varieties such as Faro, Paha and Tyee. We plan to counter this problem by breeding earlier wheats.

3. We don't know why but clubs, beardless types and the short-two gene dwarfs tend to do well under no-till after grain.

4. Many wheats with high yield capacity under conventional tillage also have high yields under no-till. But we have found that the high yielding types often suffer a proportionally greater reduction in yield than do types with less yield potential.

5. We have monitored milling and baking quality of wheats grown under no-till and tillage. No special problems have been encountered. There is a tendency toward somewhat lower protein content with no-till but this should be an advantage for our soft wheats. No consistent effects were noted on milling quality.

6. At least in some of our tests we have encountered more lodging among certain wheat cultivars under no-till.

7. Although we are certain successful stand establishment is needed under no-till, we have not been able to identify any consistent pattern for this trait among wheats that we have tested so far under no-till.

SEEDLING VIGOR GENETIC STUDIES

R. E. Allan, J. Chun, J. A. Pritchett,
M. L. Baldridge, L. M. Little, and M. A. Patterson
USDA-SEA-AR

Screening germplasm for seedling vigor requires much time, space and labor. We are limited by how many individual lines can be field tested. In one season we can normally test about 1000 individual lines. Often as few as 1% of these lines show improved seedling vigor when compared to cultivars like Moro and Sprague. Hence we urgently needed a way to increase our odds of finding a greater proportion of lines that have excellent potential for seedling vigor.

Each season we evaluate 15,000 to 25,000 early generation lines for preliminary disease and agronomic information, but it would be an impossible task to screen all of these lines for seedling vigor tests. We also make about 250 to 400 new crosses each year. If the genetic worth of these crosses could be reliably tested for seedling vigor we could then concentrate our individual plant evaluations only on the very best crosses.

Based on the results over the last 3 years we have been able to show that it is feasible to test bulk populations for seedling vigor and that the performance of these bulks gives us a good indication of which populations will have the most individual lines for improved seedling vigor. After initially testing 283 bulk populations for emergence rate, five populations were shown to contain 43% of those lines identified as distinctly superior for seedling vigor among 1066 individual lines tested. We found out that if we only concentrate our individual line tests on populations that rank in the top 5% for seedling vigor we still end up recovering over 85% of the lines with the best individual emergence potential. This discovery should greatly help us identify types for improved seedling vigor and allow us to sample a broader base of germplasm in any one season.

GENETICS OF DISEASE RESISTANCE

R. E. Allan, R. F. Line, G. W. Bruehl, and J. A. Pritchett
USDA-SEA-AR-WARC

Strawbreaker Foot Rot: We should gain excellent data on the inheritance of resistance to strawbreaker foot rot this year, thanks to excellent cooperation of Mother Nature and a new inoculation method perfected by Dr. Bruehl. This severe test should help us determine whether we can pyramid different levels of resistance to get even higher forms of resistance. We should learn how frequently we can expect to recover the resistance carried by such wheats as Cerco, Viking, Cappelle and VPM. It may be possible to get some idea of how many genes control resistance in some of these sources.

We have over 35 crosses involving 800 individual lines planted both at Pullman and Puyallup. We hope this severe test reduces these 800 lines down to only a few that will be logical candidates for parents or perhaps commercial varieties.

***Cephalosporium* stripe:** Last year we had an excellent chance to learn more about the relative level of tolerance of our various wheats to this disease. An early sown yield nursery at Pullman was heavily infested with this fungus. We rated tolerance on a 1 to 9 scale wherein 1 and 9 represented low and high expression of signs and symptoms of the disease, respectively. The table below lists the ratings, yields and heights of several varieties:

Variety	Rating	Yield (bu/A)	Ht. (cm)
Tyee	3.8	72.4	82
Faro	4.0	68.8	81
Barbee	5.5	65.9	86
Paha	6.0	58.7	86
Nugaines	2.0	71.2	80
Luke	2.5	71.8	82
Daws	3.3	75.8	82
Stephens	8.7	40.7	64
McDermid	9.0	39.2	65

Nugaines, Luke and Daws have good tolerance to the disease, produced moderately high yields and showed very little plant stunting. Stephens and McDermid were highly susceptible, had low yields and were severely stunted. The club wheats tend to be intermediate for tolerance to *Cephalosporium* stripe.

Tolerance to this disease may be genetically complex. At least it is not easy to recover tolerant lines among crosses of tolerant and susceptible parents. Among a backcross population of Early Blackhull/Nugaines//Nugaines only 2 of 50 lines had disease ratings equal to Nugaines even though we had backcrossed once to Nugaines. In theory these lines should possess about 75% of the genetic makeup of Nugaines.

Rust and Mildew: Progress has been slow on combining suitable resistance to both leaf rust and stripe rust. We selected about 300 F_5 lines from 18 different crosses in 1979 that showed good resistance to both stripe rust and leaf rust. We found 25 new sources that give resistance to both leaf rust and stripe rust. Many of these wheats come from Northern Europe and Russia. We are just now getting a look at the progeny from crosses of these wheats to our adapted varieties.

WA 6472, the multiline club wheat developed to combat stripe rust resistance, has performed well agronomically. It represents a mixture of ten lines that have at least eight different types of stripe rust resistance. This diversity of resistance should greatly reduce the vulnerability of our club wheats to stripe rust. Evidence suggests Moro, Barbee, Faro and Jacmar all have the same type of stripe rust resistance. So one new race could knock them all out. WA 6472 is not damaged by powdery mildew as severely as other club wheats currently in production. It also appears to be more generally adapted to a wider production area than clubs such as Paha, Barbee and Faro.

WBP 7815 is a new semidwarf club wheat which has resistance to stripe rust, leaf rust and mildew. It appears to derive at least part of its resistance to these foliar diseases from spelt wheat. It is in the regional tests for the first time this year. This line is being used heavily as a parent.

SMALL GRAIN MANAGEMENT AND PRODUCTION

A. J. Ciha and Helen Murray
USDA-SEA-AR

Objectives—The main objectives of this research are: 1) to examine and identify varieties of winter wheat best suited for a particular tillage system; and 2) to examine cultural practices for spring grain production.

On-Going Research—In 1979, overall plot yields of winter wheat in the annual cropping system were reduced approximately 50% due to late fall rains and poor plant growth prior to the winter. There was no significant difference in yield among the tillage systems (conventional, minimum, or no-till) examined. In the fall of 1979 fall rains did not arrive until mid-October making weed and volunteer grain control more difficult. Continuous no-till winter wheat plots tend to build up cheatgrass, which seems to be controlled with a spring grain-winter wheat rotation. Several plots to examine the effects of seeding rate (50, 75, 110 lbs per acre) on various tillage systems were established using Daws and Stephens winter wheat. Preliminary observations suggest that a higher seeding rate may be needed with no-till.

Production practices examined with the spring grains include seeding rate, planting date, and tillage. At Pullman, delaying seeding from the first of April to mid-April reduced yields 4% for spring wheat and barley and 8% for spring oats over a 3-year period (1977-1979). Over the same years, delaying seeding to the first of May reduced yields an additional 12% from mid-April seeding for the spring grains.

From 1977-79 average grain yields for the spring grains showed a small significant reduction with a low (0.6 bu/acre) seeding rate over a medium (1.2 bu/acre) while there was no yield advantage of a high (2.0 bu/acre) over a medium seeding rate. There was no seeding rate x planting date interaction.

A spring wheat and barley tillage and planting date plot was established at Dayton in 1979. Where weeds were controlled by herbicides, there was no significant effect of tillage (conventional, minimum, or no-till) on yield. Test weights and 100-seed weights were reduced when going from a conventional tillage to a no-till system. Delaying seeding from the first of April to the first of May significantly reduced yields and test weights.

Experiments have been established in various rainfall locations within SE Washington to identify locations where the annual cropping of spring grains would be feasible. Sites are at Lind, Harrington, Colfax, and Pullman with 8-10'', 13-14'', 16-18'' and 20-22'' annual rainfall, respectively. In 1979, Lind and Harrington were extremely dry with only 3-4'' of available moisture in the soil profile. Grain yields ranged between 8-15 bu/acre at Lind to 13-22 bu/acre at Harrington depending on variety and tillage operations. For 1980, a site at Pullman has been established and a site at Colfax has been started for a 1981 seeding.

DATE OF SEEDING WINTER WHEAT STUDIES

E. Donaldson and M. Nagamitsu

For the past several years a date of seeding winter wheat trial has been conducted on the Dry Land Research Unit at Lind. Starting the first of August through the month of October, a seeding is made about every 10 days. The main accomplishments have been to explore the hazards of early seeding. The earliest dates of seeding have experienced yield reductions greater than those occurring in later seedings due to drouth, aphids, barley yellow dwarf, and late spring frosts.

The average yields for five varieties for the years 1974-78 are given in Table 1. There is no significant difference in yield for any variety for any seeding date in September. Nugaines is adapted to the widest range of seeding dates of the selections tested. Wanser has perhaps the shortest range of adaptability.

Among the varieties tested none are adapted to early (early to mid August) seeding since none are resistant to the afore mentioned hazards of early seeding.

Table 1. Yield (bu/acre) of five winter wheats grown for five years 1974-78 at Lind.

Approx. Seeding Date	Variety				
	Wanser	Nugaines	Sprague	Moro	Paha
Aug. 2	22	25	27	23	26
Aug. 14	22	27	31	26	26
Aug. 22	26	34	31	30	35
Aug. 31	30	37	35	32	39
Sept. 11	34	39	39	38	41
Sept. 25	36	39	37	39	43
Oct. 2	31	37	35	34	41
Oct. 12	29	38	34	35	35
Oct. 23	22	25	19	18	21

WEED CONTROL IN WINTER WHEAT

Metribuzin (Lexone, Sencor) Research Results In Eastern Washington

D. G. Swan and T. L. Nagle
Washington State University

Lexone (DuPont) and Sencor (Mobay) herbicides are now registered for weed control in winter wheat. The registrations are 24C or special local needs labels. If you decide to use metribuzin (common name for Lexone or Sencor), be sure to follow the label directions exactly.

The following is a summary of several years of research results in eastern Washington.

WINTER WHEAT—Metribuzin application rates of 0.25-1.2 bu/A (active ingredient)

Fall Application

Preemergence—crop injury was 0-30%. Downy brome (cheatgrass) control was 20-80%, and all rates caused a yield reduction.

Postemergence—winter wheat 2-4 leaf stage of growth. Crop injury was 0-10%. Downy brome control was 60-100% and jointed goatgrass control was 100%. Crop yield reductions were measured most of the time.

Postemergence—winter wheat 10 leaf stage of growth. Crop injury was 10-50%, and downy brome control 90-100%. The low rates did not reduce yield.

Combination—metribuzin 0.25-1.2 lb/A plus terbutryn (Igran) 0.6-1.2 lb/A (all active ingredients). Growth stage same as above. Crop injury was 0-40%, and downy brome control 90-100%. Low rate did not reduce yield.

Spring Application

Postemergence—winter wheat 4-6 leaf stage of growth. Crop injury was 0-50%. Downy brome control was 40-100%, and broadleaf weed control was 100%. The low rate did not reduce yield. High rates reduced yields over half of the time.

Postemergence—winter wheat 30-50 leaf stage of growth. Crop injury was 0-30%, and downy brome control was 40-90%. The low rate did not reduce yield, and the higher rates reduced yield about half of the time.

Combination—metribuzin 0.25-1.2 lb/A plus terbutryn 0.6-1.2 lb/A (all active ingredients). Growth stage same as above. Crop injury was 0-20%, and downy brome control was 80-90%. There was no yield reduction due to treatment.

Table 1. Summary of weed control data comparing metribuzin applied in the fall and spring to winter wheat in eastern Washington.

Treatment	Wheat injury (%)	Downy brome control (%)	Wheat yield (bu/A)
	Fall applied		
Metribuzin	60	90	24
Weedy check	0	0	33
	Spring applied		
Metribuzin	10	70	41
Weedy check	0	0	42

Weed control is less when metribuzin is applied in the spring but crop safety is increased.

Table 2. Summary of weed control data comparing rates of metribuzin applied to winter wheat in eastern Washington.

Treatment	Rate lb/A (active ingredient)	Wheat injury (%)	Downy brome control (%)	Wheat yield (bu/A)
Metribuzin	0.25-0.3	20	70	39
Metribuzin	0.5-0.6	40	80	35
Weedy check	—	0	0	44

Downy brome control, with higher herbicide rates, does not increase as fast as the crop injury.

These data are research results and are not to be construed as recommendations.

CROP PRODUCTION AND SOIL PROPERTIES

A. R. Halvorson
Extension Soil Scientist

For cereal production under dryland conditions, the properties of the soil are of major importance. For example, the soils of the dryland wheat-producing area of eastern Washington have an especially generous moisture-holding capacity. Since our cereal crops are grown largely on stored soil moisture, that extra water storage capacity means extra bushels of grain. The water intake rate of our soils is quite good, and fortunately much of our rainfall comes as the more gentle type rather than a high proportion as cloudbursts. Nevertheless, too much erosion is occurring. The exposed subsoil has a considerably slower water intake rate than good topsoil. Subsoil is more subject to compaction, and compaction further reduces water intake rate and water storage capacity. Management of all factors that influence crop yield must be considered if maximum return from applied fertilizer is to be expected.

The management of the physical properties of soil has lagged behind our management of soil fertility. Greater efficiency of utilization of fertilizer can be gained by improving our management of soil, i.e., reduction of erosion and reduction of soil compaction.

SOIL FERTILITY MANAGEMENT FIELD TRIALS FOR WHEAT PRODUCTION

Fred Koehler, Marvin Fischer, Emmett Field, and Raymond Meyer

There are approximately 40 field experiments concerning soil fertility management for wheat production being conducted in 1980. These are distributed throughout the wheat producing area of eastern Washington from Asotin to Waterville (see map and lists of grower cooperators for locations).

A total of 14 no-till experiments are under way in 1980. In three large studies no-till is being compared with conventional tillage with both spring and winter wheat using various combinations of fertilizer materials and rates. Three similar studies involve only a no-till management system. At other locations variables include placement method, rate of nitrogen fertilizer, source of nitrogen, and the use of nitrification inhibitor.

The use of spring top dressing with nitrogen for winter wheat is being studied. Treatments include rate and source of nitrogen as well as the use of sulfur in addition to nitrogen.

At Spillman Farm there is a long term study on the effect of soil acidity on wheat and pea production. Three levels of soil acidity have been established. Superimposed on these treatments are sources of nitrogen (ammonium N versus nitrate N) and the use of trace elements. To date there has been no effect on wheat yields.

Other experiments include further studies on nitrogen sources and rates for winter wheat, source and rate of phosphorus fertilizer, use of sulfur, time and methods of using dry fertilizer in a wheat fallow rotation, rates and sources of nitrogen and sulfur for spring grain, and sources and methods of application of various kinds of fertilizers with a no-till system.

In 1978 there were several responses to spring top dressing of winter wheat. All nitrogen fertilizer materials gave similar yield responses. In the no-till experiments, where moisture was limiting, no-till resulted in higher yields than did conventional tillage. In other experiments where moisture supply did not limit yields, the highest yields were produced with conventional tillage. In the higher rainfall area, weed problems were more severe than in earlier years, presumably because of heavier than normal late spring and summer rainfall. Band placement of nitrogen and sulfur fertilizer for spring wheat with no-till was much more effective than was surface broadcasting these materials.

In 1979 there was severe rodent damage to many of the no-till sites. At sites where there was both no-till and conventional tillage, the damage was more severe in the no-till plots. Where meaningful data could be obtained, yield responses were similar to those obtained in previous years.

THE EFFECT OF CROP RESIDUE HARVESTING AND TILLAGE ON CROP PRODUCTION AND EROSION

L. F. Elliott, D. K. McCool, V. L. Cochran,
R. I. Papendick, and K. E. Saxton
USDA-SEA-AR

Crop residues are potential energy sources such as fermentation to alcohol, burning for heat, and animal feed. However, crop residues are important in the field for water and wind erosion protection, as reservoirs of plant nutrients, and for maintaining soil organic matter and tilth.

This long-term project (funded by the Department of Energy) was initiated in 1979 to determine the effect of tillage and crop residue harvesting on plant nutrient conservation, erosion protection, soil organic matter maintenance, soil water holding capacity, and crop production. There are indications that as tillage systems are changed, i.e., complete tillage to minimum tillage, less crop residues will be required for erosion protection and maintenance of soil organic matter. However, we must have these data before residue harvesting occurs so that irreparable soil damage does not occur.

The plots are set up to compare soil losses by water erosion from areas conventionally tilled and planted versus areas no-till seeded with surface crop residue rates of 1500, 3000, and 6000 lbs/A left on the plots. The cropping system is a winter wheat-spring rotation. The crop residues and grain are analyzed for nutrients so nutrient loss can be calculated; and the soil is analyzed for nutrients, soil organic matter, and water content so the effect of crop residue harvesting and tillage on these factors can be determined. The amount of soil, nutrients and water lost in runoff is measured to determine the environmental effects of both tillage and crop residue harvesting.

It is too soon to provide any trends at this point. The project will likely require 10 to 15 years for definitive answers although some trends are expected after three to five years of study.

CROP RESIDUE MANAGEMENT IN NO-TILL WINTER WHEAT

V. L. Cochran, L. F. Elliott, and R. I. Papendick
USDA-SEA-AR

Direct drilling crops into cereal residues effectively decreases soil erosion, but often crop yields are reduced. This is particularly true where large amounts of crop residues remain on the surface, such as in the center of the combine path or in low heavy residue areas of the field. The plants in these areas are often chlorotic, unthrifty and stunted. The problem seems related to the production of toxins during straw decomposition. After a cool, wet period of three or more days, chemicals (toxins) which are very inhibitory to wheat plant root growth can be extracted from the decomposing residues with water. They disappear when the residue dries or the weather warms. The toxin(s) is rapidly deactivated in the soil, thus the plant must be in close contact with the decomposing residue to be injured.

Plant injury occurs at two growth stages; when the seedling is emerging and contacts crop residue pushed into the seed furrow; and when the secondary roots are forming. Where the plant emerges through a residue mat, it sets a high crown. Often the high crown is set in the residue mat so the secondary roots are in intimate contact with the residue before entering the soil.

Grain drills designed to move the crop residue away from the seed row would avoid placing the seed in direct contact with the straw and would allow normal crown set. The effect of the toxin(s) on either the primary or secondary root would be minimized. A study evaluating the feasibility of moving the straw away from the seed row was initiated in the fall of 1976. However, the first season was unusually dry and no toxins were found and the drought masked damage to the crop due to heavy residues. The 1977-78 weather was ideal for the production of toxins, but crop residue levels were low because of the past year's drought. Early spring data indicated that, where winter wheat was directly planted into either spring or winter wheat stubble without moving the straw from the seed row, plant stands and tiller numbers were reduced by 20% compared to conventional tillage or direct seeding with straw moved from the seed row. However, no significant differences in grain yields were found between tilled or no-tilled treatments on either spring or winter wheat stubble. Yields were 90 bu/A or above on both sites for all treatments.

The dry fall of 1978 resulted in poor winter wheat emergence in the plots direct seeded into winter wheat stubble, but did not seriously reduce emergence of any of the seeding treatments into spring wheat stubble. Generally, in the plots direct seeded into winter wheat stubble, overwinter emergence in the straw away from the seed row treatment was much better than the straw in the seed row treatment. Further injury to the plants in direct contact with the heavy residues occurred shortly after application of bromoxynil and diuron mix to control broadleaf weeds (primarily mayweed). Where the straw was moved from the seed row, no visible injury occurred. All the plants showing injury were found to have high crowns with secondary roots in the straw mat. There was no visible herbicidal injury to winter wheat direct seeded into spring wheat stubble because the residue levels were much lower and the winter wheat plant did not set a high crown. Over winter water storage was 4-in. greater in the direct seeded plots with surface residue than in either the tilled or direct seeded plots with surface residues removed. This additional water resulted in a 15 bu/A yield increase and higher test weights from the direct seeded plots with surface residue than from either the tilled or direct seeded plots with crop residues removed.

The three year average yields were not significantly different between tilled or direct seeded into winter wheat stubble. However, where planting winter wheat followed spring wheat, there was an average increase of 5 bu/A as a result of direct seeding compared to planting into tilled ground. This yield increase corresponds to the increased water storage as a result of surface residues. The lack of such a response to winter wheat direct seeded into winter wheat stubble is due largely to poor grassy weed control and/or biological problems caused by heavy residues. At no time was a significant yield decrease found from direct seeding of winter wheat into either spring or winter wheat stubble.

RUNOFF AND EROSION PREDICTION AND CONTROL

D. K. McCool, K. E. Saxton and R. I. Papendick
USDA-SEA-AR

Erosion Prediction (USLE)

A continuing effort of the SEA-AR Land Management and Water Conservation Research Unit at Pullman is to adapt the Universal Soil Loss Equation (USLE) to the region for use as a soil and crop management planning tool and to predict the effect of changes in management on soil erosion and water quality. The USLE uses factors for rainfall and runoff, soil type, slope length and steepness, crop management, and erosion control practice in predicting long term average soil losses in tons per acre. The first generation adaptation was developed in 1974 and is currently being used by the Soil Conservation Service in applicable portions of Idaho, Oregon, and Washington. The equation has recently assumed more importance as the only tool currently available to assess the effect on soil erosion of the Best Management Practices developed under Section 208 of the Public Law 92-500.

An erosion survey across Whitman and Latah counties and a more localized study to determine the effect on erosion of slope length and steepness are part of the USLE effort. Soil loss is measured with the rill meter, a 6-foot wide device that photographically records soil loss. The erosion survey has been conducted since 1974 and the slope length and steepness study since 1973. Results indicate that slope steepness has much less effect on erosion here than in the Midwest. Erosion hazard maps are being developed.

Effect of Crop Management and Runoff and Erosion

Runoff plot studies to compare the effect of land treatment on runoff, soil loss, and water quality have been installed on the Palouse Conservation Field Station (PCFS) in cooperation with the Agricultural Engineering and Agronomy/Soils Departments of WSU. The studies include such treatments as conventionally seeded annually cropped winter wheat, a winter wheat/summer fallow rotation, no-till winter wheat seeding, no-till winter wheat seeding with vertical slotted mulch, and various rough tillages and standing stubble in preparation for spring crops. The vertical mulch is a new technique being tested to maintain water infiltration even under frozen ground conditions. Most of the studies were started in the fall of 1976. Because of the drought and lack of runoff, no erosion occurred in that season. The 1977-78 runoff season was also influenced by the 1976-77 drought in that soil moisture was still quite low on all treatments and crop yield and residue production was also quite low. The result was that the only treatments to yield significant runoff were the no-till seedings. This is believed to be primarily the result of the low amounts of surface residue available for protection. The 1978-79 runoff season was dominated by the extended period of deep soil freezing under a heavy snow cover. The soil remained frozen until the snow cover melted. Shortly after the soil became bare and started to thaw from the surface a rainstorm caused severe erosion to the finely tilled treatments. Total season soil loss on winter wheat after summer fallow was 11.6 tons per acre with runoff of 6.1 inches. Soil loss on recropped wheat was only 2.4 tons per acre with runoff of 4.0 inches. Soil loss from no-till seeded into spring wheat stubble was only 0.5 tons per acre with runoff of 4.5 inches. The 1979-80 results are not yet available.

Slot-Mulch Development and Testing

We have continued to develop the concept, theory, and capability of the slot-mulch practice where a soil slot about 3 inches wide and 10 inches deep is compacted with straw and chaff and left open to the soil surface for water infiltration even under shallow frozen soil conditions to prevent runoff and erosion. Test plots in the spring of 1979 during a significant frozen ground event showed that this practice averaged less than 0.4 inch of runoff while almost all other treatments had 4 to 6 inches of runoff.

We have developed a small research machine to cut the soil slot with a rotary wheel and fill it with straw supplied from bales. Several test plots were established in September 1979 on the Palouse Conservation Field Station (PCFS) and near Colfax on no-till wheat stubble and also on grass-seeded knobs near Colfax. Winter conditions did not develop to provide any significant test data, but machine experience and design criteria were developed. A cooperative project has been developed with the Agricultural Engineering Department of WSU to design and build an improved research machine to further the testing of the slot-mulch practice.

In April 1980, while the soil profile was wet to near field capacity, we tested the infiltration capacity of the slot-mulch in an unfrozen state by filling the slots with water and maintaining them near full with a float and recording supply tank. Ten separate slots at the PCFS were tested for periods of 3 or 4 consecutive days with water maintained in the slot for about 12 hours each day. Preliminary results indicate that the average 3-day infiltration would be equivalent to a water depth of 10 inches if the slots were spaced 12 feet apart. Nearly 5 inches depth infiltrated the first day, about 3 inches the second day, and then 2 inches each day after. These are for a given soil and situation and are near the potential to be expected, but we are encouraged by the significant magnitude which supports the 1979 frozen-ground runoff observations. Additional testing and theory development on the soil water movement is being done by a cooperative project with the soils staff of WSU to define effects of slot dimensions, soil characteristics, and soil freezing.

Evaluation of Latah County Five-Point Program

A current project of the Land Management and Water Conservation Research Unit in cooperation with the Agricultural Engineering Department of the University of Idaho is to evaluate the effect on soil erosion and water quality of the Five-Point Program of the Latah Soil Conservation District. The Five-Point Program consists of the following elements: (1) Restricted summer fallow, (2) Minimum tillage, (3) Contour seeding, (4) Divided slope farming, and (5) Critical area treatment. The study was undertaken as part of the Section 208 area-wide waste treatment planning effort established by Public Law 92-500, Water Pollution Control Act Amendments of 1972. The study includes runoff plots to evaluate the effect on runoff and soil loss of such treatments as divided slope and minimum tillage, rill meter studies to evaluate more conventional treatments, and downstream sampling sites to attempt to relate water quality to upland treatment. The project was started in the fall of 1976 but, because of the drought, little or no data were collected in 1976-77. The only visible erosion occurred on fields planted to winter wheat after peas. The 1977-78 erosion season was more typical with several runoff events starting in late November. Again the winter wheat seeded into pea residues suffered the largest soil loss and produced the largest amount of sediment moving past the downstream gaging station. There was no winter wheat following summer fallow in the study area. The 1978-79 erosion season was dominated by frozen soil and a deep snow cover. Because of the deeper snow cover in the area the fields did not suffer the high erosion rates observed on the PCFS plots in 1978-79. Winter wheat after summer fallow produced the largest soil loss followed by winter wheat after peas. Winter wheat after small grain produced the smallest soil loss of the seeded wheat treatments.

EXPERIMENTS WITH STRAWBREAKER FOOTROT

G. W. Bruehl, R. Machtmes, T. Murray

For years our standard, reliable method of inoculating the footrot nurseries was to use sterilized oat kernels upon which the pathogen had been grown. In 1978-1979 results were poor. In retrospect, the prolonged dry fall was followed by a cold winter. The pathogen did not sporulate adequately because it was too dry in the fall and too cold in the winter.

In contrast, we inoculated some materials with spores in a water suspension in November. Disease was severe. In other words, spore production and dispersal limited disease development in 1978-1979.

It is important that inoculations don't fail. Failure loses a year in the breeding program. The direct use of spores can eliminate one source of failure. In 1979-1980 we have trials on the spore concentration and on the most effective time of year to inoculate.

Tim Murray is studying characteristics of wheat that make it resistant to footrot. He has concluded that resistance is complex, involving both physiology and anatomy. We are pleased with his progress.

We are testing Benlate and Mertect for control of footrot, particularly in respect to date of application. We must know when it is too late to spray.

If you used Benlate and it did not control footrot, please provide G. W. Bruehl with as many details as possible.

For two consecutive years Benlate applied in the fall reduced winter hardiness.

The prospect for development of wheats so resistant to footrot that no fungicide is needed is excellent. Two main problems exist: (1) to get enough hardiness into footrot resistant wheats, and (2) to have a highly efficient and accurate test for resistance. Progress is being made on both problems.

WINTER DISEASES OF WHEAT AND BARLEY

G. W. Bruehl, R. Machtmes, D. Gertenbach

Breeding for snowmold resistance was hindered again in 1978-79 by a lack of snow and moisture in Douglas and Okanogan Counties. We obtained useful yield and quality data on our advanced wheat lines in Lincoln County on the H. P. Carstensen, Jr. (Almira), J. Sheffels (Wilbur), and on the R. Kramer (Harrington) ranches, however. The yields encouraged us (Table 1). All lines had better straw than Sprague.

Table 1. Yields of wheat lines that may replace Sprague in the snowmold areas. Yields are bushels per acre.

	Yields			
Selection	Almira	Wilbur	Harrington	Pullman
77-294	25.3	47.3	56.0	97
Sprague	29.8	43.7	53.5	82
77-13 (club)	28.3	41.3	54.8	97
77-94	26.6	44.8	53.0	110
77-99	27.5	39.7	50.4	103
Luke	20.0	38.7	46.4	97
McCall	24.6	38.3	44.5	73

In 1979-1980 we obtained meaningful snowmold data on the Goldmark Ranch in Okanogan County (Table 2) and hardiness data at Lind and Pullman (Table 2).

Table 2. Snowmold and hardiness observations, 1979-1980.

Selection	**Snowmold resistance**	**Hardiness**	
		Lind	**Pullman**
77-294	70	96	95
Sprague	68	95	—
77-13	58	96	95
77-94	53	99	98
77-99	47	97	95
Daws	25	93	98
Luke	10	93	—
Hyslop	0	44	50
Stephens	2	40	37
Hatton	3	100	98

We inoculated wheat west of Mansfield (H. Beard Ranch) and east of Okanogan (P. Goldmark Ranch). The wheats were planted within a day and inoculated within a day in each nursery. Wheat in inoculated rows died in the Beard Nursery, lived in the Goldmark Nursery. The wheat in the Beard Nursery was weakened by sub-normal soil moisture at planting time and until late fall. The wheat in the Goldmark Nursery was seeded into good moisture and it was vigorous going into winter. Host vigor has a great influence on snowmold resistance.

So far as we know, Selection 77-294 emerges well, is as hardy and as resistant to snowmold as Sprague. It has stronger straw and better quality. It is a short common soft white.

Selection 77-99 is our best hard red. It has good quality and excellent straw. It is probably less hardy than most hard reds and it is not equal to Sprague in snowmold resistance. It could be useful in areas with only moderate need for snowmold resistance.

Luke (Table 1) yielded less than normal. It normally equals Sprague in the area represented. Also, in Table 2, Luke ranked poorer than normal for snowmold. It normally should have scored a 30-40 on the above scale. Mold resistance, like hardiness, seems to shift with many circumstances.

This is our first experience with Daws. More experience is needed before we will really know how good it is for snowmold. This is the poorest showing Luke has made.

For two winters, in cooperation with R. A. Nilan and Steven Ullrich, Doug Gertenbach has tested winter barley near Harrington. The objective is to extend the range of this plant by increasing its winter survival. Some barleys are hardier than those now in use here, but we still do not know whether they will resist the winter fungi sufficiently to justify extending winter barley production further into the Columbia Basin.

We study methods of identifying snowmold pathogens in the laboratory at Pullman.

TAKE-ALL OF IRRIGATED WHEAT

R. James Cook
USDA-SEA-AR

Take-all is a root and footrot of wheat limited mainly to the irrigated areas. The disease appears as blackened roots, crown, and lower stem. Diseased plants occur in patches.

Take-all is controlled most easily by crop rotation where wheat on barley is grown no more than every other year. Potatoes are a good rotation crop. Alfalfa is also a good rotation crop, provided the stands do not become infested with cheat or other grassy weeds which host this fungus.

Take-all can also be controlled to a remarkable degree in monoculture wheat, owing to a spontaneous biological control that comes into play by the third, fourth, or sometimes not until the fifth consecutive wheat crop. Our research is concentrated on finding the cause of the biological control so it can be used more effectively (without having to wait three to five years). Our research is also concentrating on practical measures that farmers can use to reduce take-all in addition to any control provided biologically. The following practices have been shown to help reduce take-all in wheat after wheat.

1. Use sufficient tillage to fragment and bury infected plant tissues. Delay fall seeding or follow winter wheat with spring wheat or barley to permit maximum time for the crop residue to rot. Take-all is favored by no-till.

2. Keep the soil surface as dry as possible during the growing season. If possible, apply all water for the crop in a few large allotments, thereby permitting the soil to dry between irrigations. This is not possible with pivots, which is why take-all is most severe with pivot irrigation.

3. Maintain good fertility. Wheat is more susceptible to take-all if deficient in any of the nutrients (N, P, K) or trace minerals. For eastern Washington, N and P are most critical.

PYTHIUM ROOT ROT OF NO-TILL WHEAT

R. James Cook
USDA-SEA-AR

Pythium is best known as a cause of seed decay, root rot, and damping-off of corn, peas, beans, and many garden plants. It has also been known for a long time among researchers as a cause of seed decay, root pruning, and stunting of wheat but has not been important in wheat in the past. However, evidence is now good that this once minor or unnoticed disease is becoming important in no-till wheat where it results in poor stands and stunted, undernourished plants.

Pythium is easily overlooked in a wheat field. The symptoms are easily blamed on poor seed or poor soil conditions. The diagnosis of *Pythium* was accomplished by: (1) isolating *Pythium* from diseased plants; (2) reproducing the symptoms under greenhouse conditions using pure cultures of *Pythium* to infect the wheat; and (3) eliminating the problem partially and in some cases totally in field plots with a chemical treatment specific against *Pythium*.

The increased *Pythium* with no-till wheat in the Palouse probably results from a combination of factors including: (1) the availability of crop residue which the fungus uses as a food base; and (2) recropping, which helps maintain high populations of the *Pythium*, and late seeding, which exposes wheat in the seedling stage to cold, wet soil, predisposing it to *Pythium*.

Research is underway with several plots in the Pullman area to test rates and methods of application of chemicals specific for *Pythium*. Several years of testing will be needed to find an economic control but eventually control should be possible.

YIELD RESULTS OF 1979 HARVESTED NO-TILL EXPERIMENTS CONDUCTED BY THE WSU AGRICULTURAL ENGINEERING DEPARTMENT

G. M. Hyde and J. B. Simpson

This report gives results of no-till experiments planted in the fall of 1978 and the spring of 1979. The fall planted variety was McDermid, the spring wheat was Fielder. Fertilizer rates were: Main Fertilizer 92 lb N/acre, 20 lb S/acre; Starter Fertilizer 8 lb N/acre, 40 lb P/acre. These rates were used on all plots. All of the statistical analyses were conducted at the 5% level of significant (alpha = 0.05).

The pea residue and spring wheat residue plots were located in an 18-to-20 inch annual precipitation area; the winter wheat residue plots were located in a 16-inch annual precipitation area; and the spring wheat plots were in a 14-to-16 inch precipitation area.

Winter Wheat Experiments, 1979 Harvest

The three types of experiments performed were a drill survey experiment on two residue types, a fertilizer placement experiment on three residue types, and an opener design experiment on 3 residue types.

Drill Survey Experiment

The drill survey experiment was performed on pea residue and on spring wheat residue, each at different locations so results between the two residue situations are not directly comparable. However, comparison of the drills within residue type is valid.

Figure 1 shows the results of the experiment for the two residues and the 8 drills or opener combinations tested plus the unfertilized check.

In pea residue, drill G resulted in significantly higher yields than drills D, F, H, and I, and drill F gave significantly lower yields than all others except I. (Alpha = 0.05).

In spring wheat residue, drill E resulted in significantly (at the 5% level) higher yield than did drill G. The unfertilized checks resulted in significantly lower yields than any other treatments. In this experiment, each drill was used to its best advantage with regard to application of fertilizers.

WSU 1978-79 DRILL SURVEY EXPERIMENT RESIDUE,
DRILL AND INTERACTION EFFECTS SIGNIFICANT,
EXCEPT DRILL ON SPRING WHEAT RESIDUE.

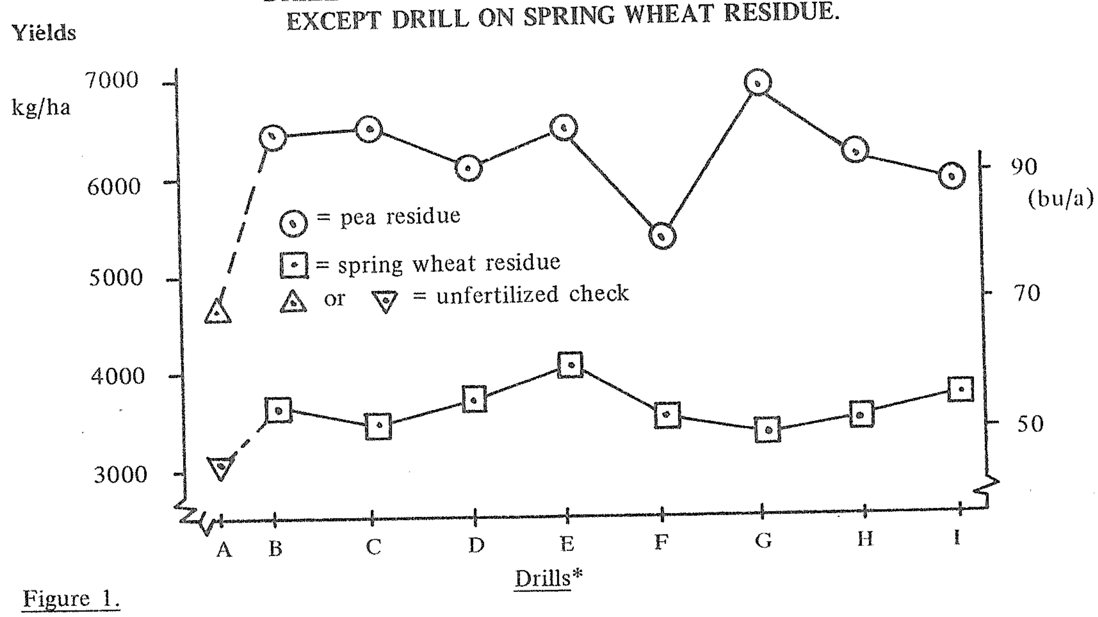

Figure 1.

* A = unfertilized check (seeded with drill D).
B = Bettinson (Melroe) 3-disk drill.
C = University of Idaho chisel planter.
D = WSU modified hoe for fertilizer, double disk seed opener behind packer.
E = Koehler plot drill using hoe for fertilizer, double disk for seed.
F = Pendleton modified HZ drill with firming plate opener.
G = USDA II large double disk opener drill (similar to Comfort King).
H = Standard John Deere HZ drill.
I = WSU modified HZ opener placing seed and fertilizer.

Fertilizer Placement Experiments

Table 1 shows comparisons between broadcasting the main fertilizer and placing it 2-1/2 inches below the seed while placing the starter fertilizer either with or below the seed. The results are for three residue types.

Table 1. Main and starter fertilizer location effects on yield for three residue types. Yields, Bu/acre.

Residue	Starter Fertilizer Location	Main Fertilizer Location: Broadcast	Main Fertilizer Location: Placed 2-1/2'' below seed
Pea	with seed	78 ab	76 b
	below seed	83 a	81 ab
Spring Wheat	with seed	56 c	59 c
	below seed	57 c	68 c
Winter Wheat	with seed	29 e	38 d
	below seed	38 d	43 d

Means with same letter are not significantly different, alpha = .05

For pea residue, the location of the main fertilizer had no significant effect on yield; however, placing the starter fertilizer with the seed had a detrimental effect on yield compared to placing it below the seed. These trials were seeded at the beginning of a dry period in October, 1978. The conclusion reached is that if any fertilizer is to be placed below the seed, then all of it should be placed below the seed rather than using a separate starter fertilizer. The trend is the same (though not significant) on the spring and winter wheat residues.

Table 2 shows effects of placing main fertilizer 1-1/4 and 2-1/2 inches below the seed with starter fertilizer either with or below the seed on pea residue.

These results indicate reductions in yield when the fertilizer is too close to the seed, especially when the starter fertilizer is placed directly with the seed. Similar trials on spring- and fall-wheat residues gave no significant differences among treatments.

Table 2. Main and starter fertilizer effects for 1-1/4 and 2-1/2 inch placement of main fertilizer on pea residue. Yields, Bu/acre.

Starter Fertilizer	Main Fertilizer: 1-1/2'' below seed	Main Fertilizer: 2-1/2'' below seed
With seed	61 b	76 a
Below seed	69 ab	81 a

Means with same letter are not significantly different at alpha = .05

Opener Design Experiments

In these experiments, four opener combinations were tried in three residue types. Colters, broadcast main fertilizer, starter fertilizer applied with the seed were common to all treatments.

The results (Table 3) show highly significant effects of residue (confounded with location), opener type, and residue-opener interaction. Within residue type, openers had a significant effect in the spring wheat residue and to a lesser extent in the winter wheat residue. In those residues, the openers that did not disturb the soil beneath the seed gave better yields than the other openers. No such trend occurred in the pea residue.

Table 3. Opener design experiments yields, Bu/A, four opener types in three residues.

	Residue		
Opener	Pea	Spring Wheat	Winter Wheat
1. John Deere HZ	83a	67b	34d
2. Double disk front	80a	67b	33de
3. Deep till clearing point and double disk seed after packer	80a	52c	29e
4. Deep till clearing point with seed tube down back	86a	47c	29e

Means with the same letter are not significantly different at alpha = 0.05.

Spring Wheat Experiments, 1979 Harvest

Spring wheat no-till trials included an experiment with large plots in which Pendleton hoe openers were compared with a deep-till fertilizer opener using double-disk seed openers behind split packer-wheels. Also, ammonium nitrate-sulfate main fertilizer was compared with urea ammonium sulfate, and starter fertilizer was placed either with or below the seed.

The results (Table 4) were that there were no significant differences among any of the treatments. There was, however, a trend toward better yield when the starter fertilizer was placed below, rather than with the seed. The conventionally-tilled and seeded check plots appeared to yield slightly better than the no-till, but the difference was not significant. The high initial fertility of the field may have masked differences in fertilizer effects.

Table 4. Spring wheat results comparing two openers, two main fertilizers, and location of starter fertilizer either with or under the seed. Residue was spring wheat, seed variety was Fielder, fertilizer rates were 100 lb N, 40 lb P, 20 lb S.

Opener	Main Fertilizer Type	Starter Location	Yield, Bu/A
Conventional till seed	-----	-------	35.1 a
Hoe fertilizer, double disk seed	ANS	Under seed	33.7 a
Pendleton hoe seed & fertilizer	UAS	Under seed	33.4 a
Pendleton hoe seed & fertilizer	ANS	Under seed	33.4 a
Hoe fertilizer, double disk seed	UAS	Under seed	33.2 a
Hoe fertilizer, double disk seed	UAS	With seed	33.0 a
Pendleton hoe seed & fertilizer	ANS	With seed	32.2 a
Hoe fertilizer, double disk seed	ANS	With seed	31.8 a
Pendleton hoe seed & fertilizer	UAS	With seed	30.3 a

Means with same letter are not significantly different at alpha = 0.05.

EFFECT OF SUB-SURFACE FERTILIZER PLACEMENT ON GRASS WEED GERMINATION AND GROWTH

L. A. Morrow, V. L. Cochran and R. D. Schirman*
USDA-SEA-AR

Nitrogen fertilizer was applied at 0, 60, 120, or 180 lb/A, either surface broadcast or placed about 3 inches below Daws winter wheat seed, to determine the effect of fertilizer placement on annual grass weeds in three types of tillage. Tillages included: 1) plowing and conventional seedbed preparation, 2) shallow incorporation of residue, and 3) seeding into standing stubble. Downy brome and jointed goatgrass were seeded to assure a moderate to dense stand of annual grass weeds. Subsurface applied nitrogen appears to reduce germination and growth of annual grass weeds as compared with that applied to the soil surface. Shallow incorporation of previous years' crop residue and seeding into standing stubble reduced soil erosion compared to plowing and conventional seedbed preparation.

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*R. D. Schirman presently WSU County Extension Agent located at Dayton, WA.

WINTERHARDINESS

Donald W. George

The winter of 1979-80 was relatively mild, but there was a brief sub-zero period in early January with spotty snow cover in some areas. Some fields were observed to have had a "patchy" cover of small drifts with bare ground between. When the variety was Stephens, the exposed areas were severely injured. Snow-protected patches were unhurt. Some growers chose to reseed while others left the original stand, hoping for recovery.

Considerable winterkill, said to be related to fall herbicide application, was reported from the Walla Walla area. Again, Stephens bore the brunt of the injury but Daws also suffered loss.

This was a season when, for unknown reasons, recovery from injury was slower and less complete than predicted from the initial observation of injury. New root growth (usually an early indicator of recovery) was slow in developing, even in plants which appeared to have only slight injury. This may have something to do with the stage of plant development as there appeared to be an unusually large number of later-seeded fields. This, together with a possibly below-normal accumulation of reserves, could have caused the poor recovery.

Field observations and reports from users continue to suggest that fall-applied herbicide tends to weaken wheat and contribute to winterkill. While little experimental evidence is available, no doubt there are differences both in varietal susceptibility and in effects of individual chemicals, with interactions to be expected.

TREES AND SHRUBS FOR DRY LAND PLANTING

Many species of trees and shrubs are included in the Station forestry project for farm-home landscaping and windbreaks. The first plantings are over 40 years old. The present testing program at Lind was started in 1928 by the Dry Land Research Unit and the Department of Forestry and Range Management, Washington State University. Plantings have been made at intervals since then. This Station planting is one of the best in the west for studying trees and shrubs adapted to dry land conditions.

Initial observation tests of woody species are carried on at the Soil Conservation Plant Materials Center at Pullman. Secondary tests are carried on cooperatively at experiment stations at Prosser and Lind, Washington, and Moro, Oregon. Station Circular 450, 1965, summarizes the results of these adaptation tests of trees and shrubs for the intermountain area of the Pacific Northwest.

A standard dry land windbreak planting consists of a minimum of three rows. When properly established, these give excellent protection from the winds. The windward row should be a tough, fast-growing shrub. Caragana is the best shrub for this purpose. Lilac is slower growing, but is hardy and makes a good dense hedge. Nanking cherry and blue leaf honeysuckle show good promise for the windward row. Where a taller shrub is desired, Russian-Olive appears to be the best adapted shrub, although a wild crab-apple shows promise.

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